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Observations on Breeding of the Marine Catfish, *Galeichthys felis* (Linnaeus)

By Gordon Gunter

Introduction and Review of Literature

THE males of several ariid catfishes carry the large eggs in their mouths until the young are hatched. The young are necessarily carried for a time after hatching, for they are helpless with the large yolk attached. Through scattered and incomplete observations these facts have been imperfectly known to ichthyologists for a long time. Lupton (1879) was apparently the first observer of North American ariids whose findings were put in print. His simple account states that in Mobile Bay in July, 1868, he found several small catfish about 10 inches long, "which seemed to have a wonderful development of the throat. On examination, the enlargement was found to be caused by small catfish and eggs which were carried in the mouth." The species was *Galeichthys felis* (Linnaeus). Gudger (1916, 1918) summarized the general literature and conducted the most extensive study that has been made on the breeding habits of catfishes practicing oral gestation. He worked with *Bagre marina* (Bloch), the gaff-topsail, one of the two species inhabiting the South Atlantic and Gulf coasts of the United States. Lee (1937) presented the most extensive observations on the other North American species, *Galeichthys felis*. Gunter (1945) gave some observations on the breeding of both species in Texas waters. In this paper some new observations on *G. felis* in Texas waters will be set forth.

New Observations, Discussion and Conclusions

On June 4, 1946, I happened by chance to run into a small group of breeding *G. felis* at the lower end of Mission Bay, near where it connects with Copano Bay through a shallow, unnamed pass cut by the 1945 hurricane. The tide was rising rapidly and the water was turbid. The fish were taken in a trammel net from 25 to 100 yards from the grassy shore of the small island lying across the mouth of the bay. The depth of the water was from 2 to 4 feet.

The observations made are of interest for several reasons. In the first place my distinct impression was that the fish were taken in the act of breeding or that the process had recently been interrupted and was not complete. Although in the past I have taken several recently spawned females and males carrying eggs, this is the first time they were caught in the act, so to speak.

Nothing could be seen in the murky water and even though the fish may have been highly excited it is probable that their actions would not have been seen. Furthermore, nothing was expected and although only 10 or 12 fish were caught, the writer examined only half of them. Part of the time I watched while Capt. Ben Earp, of the Game, Fish and Oyster Commission, extracted these valueless fish from the net and threw them overboard. With more or less idle curiosity one fish was examined and this convinced me that the fish had very recently spawned. The remaining catfish caught were

saved. Several adult blue crabs, *Callinectes sapidus,* of both sexes, and one spotted trout, *Cynoscion nebulosus,* were the only other things taken in the net. The salinity of the water was 13.6 *per mille.*

In the years 1941 and 1942, I took 33 *G. felis* males carrying eggs or young in their mouths. Only 6 came from Copano Bay, the back or landward bay from the Gulf, and only 2 of these contained eggs. In one fish the eggs were in an advanced stage of development. The other 4 males were carrying young fish. Conversely, all males carrying eggs in an early stage of development were found in the seaward bay, Aransas Bay, and the majority came from the lower part of that bay near the Gulf (Gunter, 1945, Table 18). This led me to believe that spawning probably took place in the lower bay near the Gulf, although the males dispersed themselves over all bay waters after breeding, and before the eggs hatched. It was stated (Gunter, *op. cit.*: 39) that most breeding catfish were noted in the lower bay, but that spawning may have been scattered over all bays. In the light of the present observations it can be stated that breeding takes place in the back bays, where the salinity is low, as well as near the Gulf.

Lee (1937) was of the opinion that *G. felis* breeds only in the bays, but was not sure that trawls used in her collections touched bottom in the Gulf and, therefore, could not be certain that the fish did not also breed in the Gulf. My (Gunter, 1945) trawls did touch bottom in the Gulf and there is no evidence that this catfish breeds or carries on oral gestation anywhere but in the bays. The present observations emphasize this point more strongly, for fishes which breed in low salinities are not known to breed also in waters of higher salinities such as the open Gulf of Mexico. On the other hand *G. felis* apparently breeds over a wider range of salinities than most fishes. The exact range is not known, but it probably extends from about 13 to 30 parts per thousand of salt.

One might expect that breeding catfish would be found in excited groups, congregated at least in small schools. However, Gudger (1916) did not observe any schools of *G. felis* at Beaufort, North Carolina, and he concluded that this catfish is solitary. Nevertheless, the species is quite abundant on the Louisiana and Texas coasts and, although Lee (*op. cit.*) and I have seen several at a time milling about pieces of bread and garbage in the water, no observer has reported spawning schools.

The date, June 4, is the earliest that the sea catfish has been reported breeding. Lee (1937) found catfish carrying eggs first on June 20 in Louisiana. Gunter (1945) found egg-bearing males first on June 10 in Texas. In that paper it was stated that examinations of spent females indicated the breeding season began early in June.

Only one of the 5 fish caught in Mission Bay was a male. It was 29 cm. long and contained 26 eggs in its mouth. The eggs were not strictly spherical and measured 12 by 14 mm. They were well along in development. The eyes and head of the embryos were well developed and the tail could be seen lashing about from time to time. The embryos were about 8 mm. long. The blastodisc covered about one-third of the upper surface of the egg. The vitelline veins and arteries could be plainly seen. The eggs were demersal in

the water where the parent was caught and all came to rest with the embryo on the upper surface. Development being rather far along, it was surmised that the eggs must have been fertilized about the first of June or more probably during the last days of May.

One female fish 30 cm. long contained 25 yellow eggs and numerous smaller eggs, whitish or opaque in color and around 3 mm. in diameter. This fish could not be stripped and there is some reason to believe that it was not ready to spawn. Previous females examined by the author (Gunter, *op. cit.*) had more than one stage of eggs and the smaller sizes were white or opaque.

The following females were the most interesting examined. The bloody-appearing genital orifice of a female 30.5 cm. long, first signalized that spawning was taking place. The orifice was slightly everted and the thick mucous membrane lining was heavily suffused with blood. A small plug of perfectly hyaline, small eggs protruded slightly from the orifice. As the fish was stripped a long string of this material was extruded, having a fully developed ovarian egg attached to the end. The plug was 7.5 cm. long. The large egg had a micropyle at the end opposite its attachment to the string of smaller eggs. Eleven eggs in all were stripped from this fish. The 6 large eggs following the first all had similar but smaller strings of small hyaline eggs attached opposite the micropyle. The remaining eggs came out in pairs with the small hyaline eggs, in small numbers, scattered irregularly over their surface. The last eggs did not strip easily and it is possible they did not come out normally.

Another fish 13.5 cm. long, with a similar red urogenital orifice, was stripped of 14 large eggs with numerous clear, small eggs attached, but not in the regular fashion found in the first eggs extruded by the first female. The micropyles were present.

A third female having the same external appearance of the genital orifice was not stripped, but was dissected. It was 25.5 cm. long. It contained a plug of the small, clear eggs in the short oviduct and 15 large eggs lying in a matrix of the smaller ones in the ovaries. The right ovary was the largest and was more distended than the other, which had only a few eggs, although counts were not made. Micropyles were seen on the eggs.

The micropyle has not been previously observed. It is a small stellate area, half a millimeter or less in diameter. Evidently its appearance is given by fine creases or wrinkles in the external membrane of the egg radiating from the micropyle proper. It has not been seen before in ovarian eggs thought to be in a very late stage of development or in early stages of fertilized eggs carried by the males. Doubtless, it is a very transient structure, as in most animal eggs, appearing shortly before fertilization and disappearing soon afterwards. If this assumption is correct, the presence of the micropyle may be taken as evidence that egg-laying in *G. felis* is in process or the time for it is very close at hand.

It should be added here that the peculiar flap-like modifications of the pelvic fins which arise in the females as spawning approaches, first described by Lee (*op. cit.*), were observed. They were hard, turgid and streaked with tiny

blood vessels. The appearance of these flaps and that of the urogenital orifice, the fact that the fish were so easily stripped of what was evidently not the full complement of fully developed ovarian eggs, and the presence of micropyles on the eggs were the facts which led me to conclude that spawning was apparently not concluded, and had been only recently interrupted.

All sexually developed female *G. felis* that I have previously examined contained large eggs and smaller opaque eggs. This led me to suggest (Gunter, *op cit.*) that females possibly spawned more than once a season. However, present observations indicate that instead of developing further, the small eggs are non-functional as eggs and lose their color and whatever internal differentiation they have, becoming merely sacs of clear material as spawning approaches.

No scientific observer has reported the act of spawning in the mouth-breeding ariid catfishes. Gudger (1916), speaking of the gaff-topsails, said, "How the eggs are extruded, fertilized, and transferred is not known, —". The status of our knowledge today remains the same for both North American species. Goode (1903: 379) quotes Silas Stearns as saying of this fish, "The spawn is deposited in the depression in the sand and impregnated with milt. One of the parent fish then takes the eggs in his mouth and by some movement fixes them against the gills, or between the leaves of the gills." Smith (1907) apparently accepted this statement without question for he states without quoting "—, the large eggs being first deposited in a sandy depression and subsequently taken into the mouth of one of the parents (male?)." Gudger (1918) quoted the statement again, but indicated that he did not know whether it was based on observation or conjecture.

There are several reasons why I do not believe Stearns' statement is correct. For one thing it is impossible for the large eggs of *G. felis* to become affixed "between the leaves of the gills." Furthermore, it is reasonable to suppose that the peculiar enlargements of the pelvic fins of females, which develop at spawning time, are functional and serve in some manner in spawning. Lee (*op. cit.*) says they are modifications causing the fins to form a trough and that perhaps the eggs are extruded and held there momentarily where they are fertilized before being taken into the male's mouth. Needless to say such modifications, which are probably widespread in the oral gestating ariids (see Lee's discussion and bibliography), would be of no value to fish that merely dropped their eggs in the sand. In addition, to my mind another observation precludes the possibility of Stearns' statement being correct. When the eggs of *G. felis* are extruded they are covered with a thin, colorless film of material having about the greatest adhesive power within my experience. It cements eggs in the air into an inextricable mass and works for a while under water, although it will wash away after a time. A fresh catfish egg dropped into the sand would become covered with a thick film of sand, very difficult to remove by the gentle mouthings of a male catfish.

This brings us to the point of considering the function, if any, of the small ova-like bodies attached to the large ovarian eggs as they are extruded. Figure 1 is an outline drawing of some of these eggs.

The males of many species of insects offer the females bits of nutritious

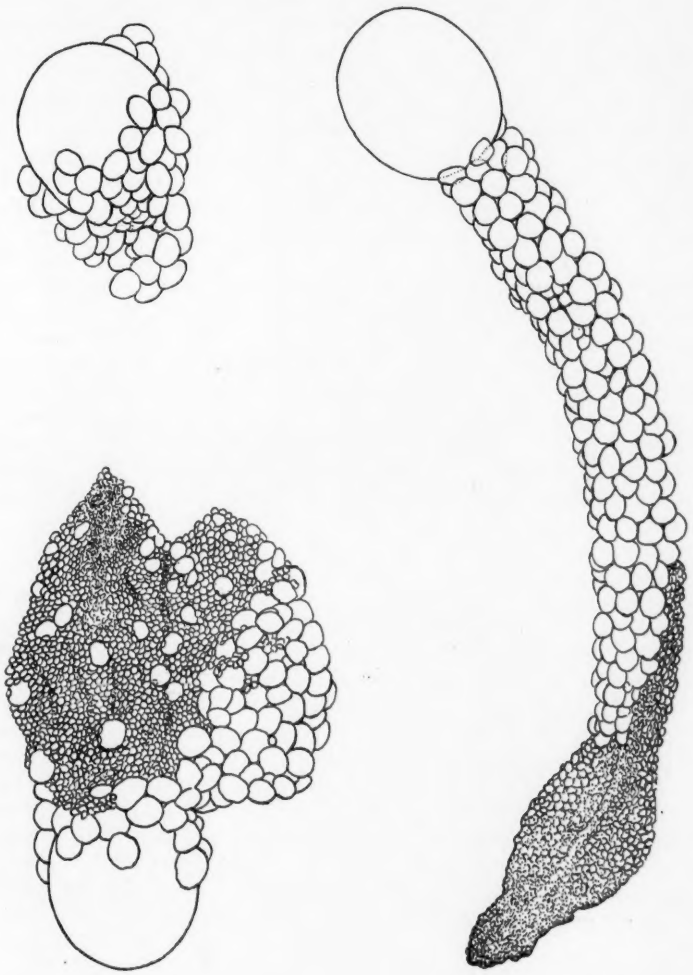

Fig. 1. The outline drawings are of ripe, ovarian eggs with non-functional, hyaline eggs attached, which were stripped from females of *Galeichthys felis*. The eggs with long plugs strip out first and the tips of the plugs are sometimes exposed exteriorly. The other two drawings are representative of eggs and their attachments, which follow the first egg in stripping. The plug on the egg to the right was 7.5 cm. long. The non-functional eggs are attached opposite the micropyle of the large egg. A fuller explanation is given in the text.

food at the time of pairing and some even sacrifice their own bodies to the female at this time. Doubtless there is a large number of scattered observations in the entomological literature on this subject. The ones I have read are those by Wheeler (1928). He says this state of affairs is possibly brought about by the great need of the female for food at the time when the eggs are to be manufactured in her body. Male catfishes go for approximately two months without food while they are carrying the young, although they remain active throughout this time. They certainly need strong nourishment before undergoing this long fast. If we may apply Wheeler's attempts at a rational explanation of the peculiar habits of insects to marine catfishes, then we might suppose that possibly the female feeds the male at spawning time with highly nutritious non-functional eggs from her own body to help prepare him for the long fast ahead. It is not clear how a male could swallow the small eggs attached to the last few extruded by the female, after his mouth is practically full, but it may be that the greatest amount of non-functional eggs are always attached to the first few large eggs coming out, just as I found in the catfish stripped. The conjecture given here is merely a suggestion and it could easily be erroneous. On the other hand it is no more peculiar than some things already known about the oral gestating ariids and nothing we know of these fishes argues against it particularly. The possibility of its correctness might be held in mind by future investigators.

Summary

A small number of breeding catfish, *Galeichthys felis*, were taken in Mission Bay, Texas, on June 4, proving that breeding may begin about the first of June and may take place in waters of low salinity (13.6 *per mille*). The genital orifice of females was bloody and partly everted, some females did not contain a full complement of ovarian eggs and could be easily stripped, and micropyles were present on ovarian eggs, indicating spawning had been interrupted. Long plugs of small, hyaline non-functional eggs were found attached to fully developed ovarian eggs opposite the micropyle. It is suggested that possibly the male takes the small eggs as a highly nutritious, strengthening food before beginning the long fast necessitated by oral gestation. Catfish eggs are covered with a highly adhesive substance when first extruded and they are probably transferred directly into the male's mouth, without first being dropped to the sand or mud.

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A Note on Protective Behavior in *Gambusia*

By C. M. BREDER, JR.

IN a series of important papers, Sumner (1934, 1935a and b) showed that specimens of *Gambusia* exposed to various kinds of predators were caught more readily against backgrounds which they did not match. He produced "dark adapted" fishes by keeping them in a black painted tank and "light adapted" fishes by keeping them in a white painted tank. Such specimens mixed half and half in a dark or light tank and then exposed to predation were found to sustain greater loss in the half of the population which did not match the background, or in other words the predators caught the conspicuous fish more easily.

Since color change in these fish is based only in part on dispersion or aggregation of the melanophore pigment and is due, to a considerable extent, to an increase or decrease in the actual number of melanophores present, it takes considerable time for these fishes to materially change their hue, as Sumner and Wells (1933) and Sumner (1943) indicated.

His experiments were carried out in open tanks without shelter or fittings of any kind. Thus the frightened fishes could only herd together, hug the walls or swim fast in efforts to escape. On general principles, while not in the least questioning the validity of Sumner's work, the artificial nature of his experimental environments and the restrictions they imposed on the behavior patterns of the fish led to the suspicion that in a state of nature the reactions involved would be much more complicated. Some experiments to check on this were planned but it was not possible to carry them out until recently, when, in fact, they were performed automatically, incident to entirely other matters.

Two artificial pools on the author's property interconnect by a small channel so that when the first is filled to make up for evaporation, it spills over and fills the second. They have been in service for various purposes for about ten years and are well overgrown with plants and to all intents may be considered as "natural" environments. A diagram of their size and layout and a general description of them is given in Breder (1946a). The first one is well shaded with trees and bushes, and the bottom is dark, being covered with a thick layer of well rotted leaves, a typical pond bottom which is very dark in color. The other was cleaned out this spring and given a bottom of light-colored gravel and is much less shaded than the other, presenting a much lighter and brighter environment. In former years both had much the same dark bottom. During the summer months for the last five years, along with other fishes, *Gambusia patruelis* (Baird and Girard) have been kept in both as an added insurance against mosquito breeding.

This year it was noted that the *Gambusia* in the first pool were in their darkest phase, while those in the second and lighter pool were in their lightest phase, both very inconspicuous against their appropriate background. It had been noted that when water was flowing from the first to the second pool often some of the *Gambusia* in the first would permit the gentle current to carry them into the second by swimming with insufficient speed to completely stem the current. Thus by the end of the summer they tended to concentrate in the second pool.

When this happened this year, since the pools have different bottoms, the incoming fish became strongly conspicuous. Other years the undifferentiated incoming fish would immediately merge with the aggregations of fish already in the pool and become indistinguishable from them. These dark fish, this year, however, behaved in an entirely different manner. They would hug the sides or bottom and dodge under a leaf as soon as possible or station themselves close to a dark stone or other object. If a light-colored resident fish incidentally approached, attempts to aggregate with it would be made but as soon as the fish moved a noticeable distance from the shelter the dark new-comer would leave the light-colored one in favor of the retreat. Furthermore, when more than one fish came over from the first pool they would not aggregate together but would scatter and find "shelter" separately. It is to be especially noted that these fish were in no way handled or otherwise frightened and that in other years the entering of a new pool did not lead to such behavior, which otherwise might be attributed to a reaction to

a strange environment. Nor was such behavior noted later, after they took on the lighter phase and became indistinguishable from the earlier residents. No light-colored fish have been seen to perform in this manner nor have the dark-colored ones in the first pool so behaved. Thus it would seem that there are at least three items which help to protect these fishes from predation when they find themselves on a background which renders them conspicuous:

1. Adjustment of a melanophore system rendering them as inconspicuous as possible. This is a slow process not immediately available.

2. Avoiding open water and seeking proximity of dark objects or resting under objects such as leaves. This is immediately available.

3. Scattering instead of aggregating. This is immediately available.

In regard to the last item it is to be especially noted that the dark fish scattered, but that there were efforts on the part of these to aggregate with light-colored bottom-matching individuals, which however was not overridden by the strong tendency to keep close to solid objects.

There is a certain amount of predation in these pools by both frogs and snakes and occasionally a wandering heron, but not enough to prevent a considerable population increase in the *Gambusia* over a summer. This predation has been observed on the matching fishes. On a basis of the previously observed behavior of both fish and predator, it would seem likely that the very "cautious" behavior of the ill-matched fishes made it actually less likely for them to be caught, in spite of their conspicuous coloration. It would seem almost that the change in behavior when the color of the fish matches that of the bottom leads to activity which may be the cause of their destruction—a kind of "overconfidence" in their inconspicuousness.

While it is well known that the eyes are the receptors mediating these changes in the melanophore system, its relationship to abrupt changes in the behavior pattern is unstudied, but the psychological bases of this should be susceptible to experimental analysis.

This species, with its considerable range of control of pigmentation, contrasts strongly with that of the goldfish, studied by Breder and Halpern (1946), who found that both yellow and gray goldfish "hid" on dark "pond bottom" backgrounds when given a choice of two, one of which matched each color of fish. This species moreover shows no such ability to modify color in association with background. See Rasquin (1946) for recent data on the pigmentary and visual interplay in the goldfish.

The speed of change of color and sometimes pattern varies widely in fishes which tend to match their backgrounds. For example, in the flounders it changes so rapidly in both respects as to be nearly instantaneous (Mast, 1916), in others more slowly as in the minnow *Ericymba* (Brown and Thompson, 1937) and *Gambusia* (Sumner, 1934 *et sub*), and practically not at all in the goldfish (Breder and Halpern, 1946). If given the opportunity to select a background, all of these will select the one on which they are least conspicuous, excepting only the xanthic variant of the goldfish, which continues to "hide" on a background suitable for the ancestral gray goldfish. The aquatic insect, *Arctocorisia,* capable of changing its color only at the time of ecdysis (Popham, 1942 and 1944), does so change appropriately

when placed in a differently colored environment. An examination of these insects for the presence of any abrupt behavior change at this time should be illuminating.

It is clear from the above remarks that in fishes so far studied in connection with color matching, none depends on this physiological activity as an apparent protective device alone but all also modify their locomotor and social behavior appropriately. Since all these items operate through the eye and are obliterated with blinding, it follows that some neuro-mechanism is capable of operating in such fishes when encountering a non-matching background as follows:

1. To adjust the chromatophores so the fish most nearly matches the background, with varying degrees of nicety depending on the species. It is perhaps more than accidental that the flounders, which not only match color but also pattern, are the only ones of this group that can see their own dorsum or side.

2. To direct their locomotion so as to bring them close to solid objects which to a considerable extent blocks the vision of predators; actually completely so from about half the possible points of vantage.

3. To modify their social attitudes so as to scatter the individuals instead of causing them to aggregate.

It will be noted that all three of the above items should serve to protect the fishes from predators. It is thought likely, in *Gambusia* at least, that when they are on the "wrong" color their active behavior probably interferes to a considerable extent with their normal life activities, such as feeding and mating. Nevertheless, in a "normal" environment with the usual pond litter, such special behavior evidently protects them very well during the period of chromatic adjustment. After they match the background and resume their normal activities, they may actually be more open to predation than before this is accomplished.

One matter of especial interest is the fact that the fishes which did not match the bottom were repelled by each other but, insofar as interfering effects permitted, were attracted to the bottom-matching fishes. It was impossible to determine with certainty just what the attitude of the matching fish was to the non-matching fish, for the adapted resident never stayed long within the vicinity of the non-adapted. This in itself is probably significant, and the general impression was obtained that an approach to such a dark fish was more in the nature of one of "curiosity," resembling rather the approach such fish will make to a small twig or seed falling into the water, which is unlike that which they ordinarily make to a fellow fish. The results obtained by Breder and Halpern (1946), indicating that groups of like-colored goldfish are more cohesive than groups of mixed color, is suggestive in this connection. This entire matter may be a further expression of the relationship between social behavior and background matching, which would seem to have its roots in the physiological and psychological difference between fishes with much melanin and those with little in relation to albedo of the background.

The close integration of the dynamics of appropriate locomotor behavior

in association with physiological chromatic change, whether fast or slow, is evidently of very considerable importance in the economy of such fishes. Other related, but more elaborate behavior associated with "camouflage" of various kinds is described by Breder (1946b). It would seem that proponents of protective coloration theories have overemphasized the type of background matching animals which depend on complete quiescence. Such, of course, actually only represent the end points of a whole series in which active locomotion plays an important part either to make up for deficiencies in the protective coloration or to enhance the deception.

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Sizes Attained by the Large Hammerhead Sharks

By E. W. Gudger

Introduction

LOOKED at "head on," sharks, with their generally flat, pointed heads, their staring eyes, their undershot mouths, have a singular and sinister appearance. In the shape of its head the hammerhead goes further, and this viewed in front, from above or below, is bizarre in the extreme. If one could see a hammerhead standing vertically in the water and facing one with only the head and mouth out of water, its appearance would certainly justify the epithet "unearthly." Many years ago, before I knew anything about hammerhead sharks, I saw such a picture. To me it portrayed a monstrous apparition from the deep, something from a nightmare.

The head is greatly depressed and markedly produced into two bilateral prolongations with the eyes at their distal extremities. Thus the head, squarish or flatly crescent-shaped in front, is very like a blacksmith's double-headed hammer or perhaps more like a croquet mallet (whence one of the fish's specific names, *malleus*, a mallet or hammer). Notable also is the long upper lobe of the caudal fin. Because of this bizarre-appearing head (Fig. 1), this fish cannot be confused with any other shark. Most hammerheads attain a large size and are credited with being both extremely ferocious and voracious—and the larger the more terrible and dangerous.

The hammerhead was first recorded from the Mediterranean, and, because of the shape of its head, its great size, and its alleged ferocity, has excited the interest of people from classical times to the present. Thus Oppian, the Greek poet, in his "Halieutics," written late in the second century A.D., says (1772, John Jones's translation, book 1: 26):

> The monstrous Balance-Fish, of hideous Shape
> Rounds jetting Lands, and doubles every Cape.

It is called "balance fish" because of the faint resemblance of its head to the common center-supported pan-weighing apparatus. The other allusions refer to its supposed wandering habits and to its widespread distribution throughout the Mediterranean. Indeed the fish is found in all tropical and warm-temperate seas.

Disregarding the comparatively small bonnethead, *Sphyrna tiburo*, the only real large hammerhead that I have seen and dissected is *Sphyrna zygaena* (*Sphyrna*, a hammer, and *zygaena*—an ancient Greek name for this fish). Indeed until recently I had thought it the only really big hammerhead in our waters, since *S. tudes* (*tudes*, hammer) had been sparingly recorded from the West Indies and from Panama. However, extensive shark-fishery operations in southern Florida have shown that it is by no means rare there. In addition a third American form, *Sphyrna diplana*, has been recently described by Stewart Springer. This form does not grow very large and will not be considered here. As will be seen, it will not be possible to give definite specific names to a few of the specimens referred to here.

No one knows how large the big hammerheads, *zygaena* and *tudes*, grow. Various authorities, following the lead of Jordan and Evermann in their *Fishes of North and Middle America* (1896, vol. 1), say of *zygaena*—"Reaching a length of 15 feet or more." And Beebe and Tee-Van, in their *Sharks of the Eastern Tropical Pacific* (1941), say of *tudes* that it "Grows to 17 to 20 feet and a weight of 1500 pounds." But none of them tell who made these measurements. At this juncture, having received some time ago a photograph and account of the capture of what was thought to be a record for size of the hammerhead, it has seemed well to bring this and other accounts together in a short article to record the facts as known. This seems the more advisable since there are known to me in the literature but two articles whose titles indicate unusual sizes for these fish. "It is reported" accounts will be disregarded; only those for which there is good authority will be included.

Authentic Accounts of Sizes

The classification of the hammerhead sharks is badly in need of revision. The species are not clearly distinguished and it seems best not to try to list sizes by species, but to consider the sharks, no matter how named by authors, merely in the order of size. The accounts now to be quoted begin with the smallest hammerhead recorded as a "large" specimen, and will end with what is apparently the record fish. Also, when possible, natural history notes about each specimen will be added.

A 10-ft. *Cestracion* [*Sphyrna*] *zygaena* is recorded by Welsh (1916) as hooked 90 miles east of Cape May, New Jersey, on August 30, 1916. It was first observed excitedly following the wake of the boat just after two swimmers had come aboard. The shark has a very "keen nose" and feeds by smell. I have seen a shark follow a blood scent up stream, swinging right and left in the changing current, like a bird dog following a covey of running partridges. Welsh's hammerhead was presumably following the scent of the bathers.

When a baited hook was cast overboard, the ravenous shark rushed at it repeatedly and when hooked put up such a fight that five men could not get it aboard. A swordfish iron was thrown into it, and then it was brought on deck and carefully measured, and later dissected. The stomach was found empty, which may in part at least account for its behavior.

From Welsh's extensive series of measurements of this male specimen, the following are noted. The length was 10 ft. (girth not given); length of upper lobe of caudal 25.5 in.; width of head 25 in.; of mouth 7.5 in.; length of claspers 11.5 in.

An 11-ft. 1-in. *Sphyrna zygaena* was found enmeshed and dead in his net at Cape Lookout, North Carolina, on July 10, 1918, by Russell J. Coles (1919). The identification of this fish is readily corroborated by the photograph of the head in Cole's Plate III, Figure 3. The girth of this female *zygaena* at origin of the first dorsal was 4 ft. Dissection showed that she had been feeding on Spanish mackerel, probably found in the net. Coles was extraordinarily successful in fishing for sharks at Cape Lookout, and will be heard from again further on.

A 12-ft. *Cestracion zygaena* is recorded by Bigelow and Schroeder (1936) as captured by a swordfishing schooner between Brown's and George's Banks, about 200 miles east of Cape Cod in August, 1928. This record is interesting not merely because of the length of the fish but because it is the largest hammerhead recorded so far north in the western Atlantic. Taken in August, it had presumably drifted in from the Gulf Stream. No measurement other than the length is given.

A 12-ft. 6-in. *Sphyrna zygaena* was taken in Beaufort Harbor, North Carolina, in July, 1906 (Gudger, 1907). This shark is the largest hammerhead ever taken at Beaufort. It was harpooned when it was swinging around an anchored fishing boat in hot pursuit of a large stingray in a narrow channel within 200 yards of the business wharves of the town. I got the fish next day for skinning and measured it. Its girth in front of first dorsal was 4 ft. 2 in.; length of hammer between the eyes, 3 ft.; length of dorsal lobe of caudal fin 3 ft. 6 in. Unfortunately there was no means for weighing it. A 12-ft. 6-in. shark is not easily weighed unless one has access to railroad track scales with a platform as long as the shark.

When dissected I found in the stomach an almost perfect skeleton of a stingray with many like fragments of other skeletons, and I got from its throat, mouth and jaws 54 stings, varying from perfect spines to broken-off tips—souvenirs of at least that many stingrays caught and probably eaten. But for all these accumulated stings, this shark was a living dynamo of energy when harpooned. The fish, hung up by the hammer, is shown in Figure 1.

A 13-ft. 2-in. *Sphyrna zygaena* from Boca Grande Key, west coast of Florida, was reported by Henry W. Fowler in 1926. It was estimated to weigh between 800 and 900 lbs. That the hammerheads are viviparous is attested by the fact that this female specimen was gravid, with 36 young each about 14 in. long. This fish also was fond of stingrays. There were in the stomach three rays each with length of disk ranging from 18 to 24.5 in. Furthermore, when captured, the jaws were clenched in a 20-inch ray. And also in the stomach were 17 spines of rays already eaten, in the gums 24 spines, and an uncounted number in the jaws. This hammerhead and that from Beaufort were, from the standpoint of food preference, two of a kind.

A 13-ft. 7-in. *Zygaena malleus* (synonym for *Sphyrna zygaena*) is recorded by Day (1880) from the Devonshire coast of the English Channel. Of it Day says, "July 31, 1865, one, 13 ft. 7 in. long was perceived floundering among the rocks at Ilfracombe [on the English Channel]: it was secured by ropes and towed inland. . . . Two thornbacks [rays] and a bass were found inside it." The hammerhead is rare in British waters and it is notable that of the specimens recorded by Day, one should be this record breaker. The largest previously recorded was, so far as I can find, only 10 ft. long. Day's specimen seems still the record in England.

A 13-ft. 9-in. *Sphyrna tudes* (?) is figured by Sigalas and Budker (1937) but without name or description. Their caption to their Figure 5 reads—"Hammerhead shark, 4 m. 15 [cm.?] long captured on the coast of Senegal."

Stewart Springer, who knows more about the hammerheads than anyone in these parts, thinks that it was probably *S. tudes*. In any case the illustration and measurement show it to have been a big hammerhead. The figure shows the fish to have had a wide hammer and a large mouth. This mouth, however, is distorted because the head is being held up by the ends of the hammer. The rather long second dorsal fin is characteristic of *tudes*.

Fig. 1. A 12-ft., 6-in. *Sphyrna zygaena* hung up by the hammer at Beaufort, North Carolina, 1906. After Gudger, 1932.

A 13-ft. 10-in. *Sphyrna tudes* was taken at Cape Lookout, North Carolina, early in July, 1918, by R. J. Coles (1919). This fish, a female, larger and heavier in build than the 11-ft. 1-in. *S. zygaena* taken at the Cape in the same season, had a hammer shorter, thicker and more corrugated in front than the other specimen. From these structures, Coles thought her to be an abnormal *S. zygaena*. But from Cole's photograph of the under side of the head, Springer identifies his huge shark as *S. tudes*. How she was taken is not stated, but of her food Coles states that:

At the time of her capture she had just eaten four of her species from my net. Two of which had been swallowed whole, except the heads of 5-ft. examples, and there were four clearly cut pieces which represented entire bodies except heads of two more 6-ft. hammerhead sharks; then the stomach contained more than a peck of vertebrae of sharks.

Since his nets had had numbers of sharks eaten from them in the previous weeks, Coles suspected that this big shark was the aggressor. Her girth at the origin of the first dorsal was 5 ft. 7 in., whereas Coles's other Cape Lookout hammerhead (11 ft. 7 in. long) was only 4 ft. in circumference. Some at least of the increased girth of the present fish was due to the great food intake of this cannibalistic hammerhead.

For a long time this 13-ft. 10-in. specimen has stood as the maximum of size for a hammerhead shark. Coles speaks of "having examined specimens over 14 ft. long"; but, since he gives no specific measurements and does not say that he measured these even for length, his statements will have to be disregarded. It is very regrettable that he did not measure these great fish and photograph them.

A 14-ft. *Platysqualus* [*S.*] *tudes* is recorded by Rivero (1936) as mounted and on exhibition in the Museum of the Instituto of Matanzas. He also states that another 12 ft. long is on exhibit in the Museum of the Instituto de Segunda Ensenanza de la Habana. No other data are given. These *tudes* sharks are large, but good fortune has brought me photographs and measurements of another "over 14 ft. long" in the flesh.

A 14-ft. 2.5-in., 1047-lb. *Sphyrna tudes* (?) was taken at Acapulco, southwest coast of Mexico, in January, 1940, by a party of which Mr. Harry Wright of Mexico City was a member. Mr. Wright, like myself, is a friend of Dr. H. M. Lydenberg, formerly Director of the New York Public Library. The latter was in Mexico City when Mr. Wright returned from Acapulco, and obtained from him and passed on to me a statement of how this big hammerhead was captured. Correspondence with Mr. Wright brought a series of photographs of the huge fish. Unfortunately the data had to be pigeonholed until this late day—when I could get at it.

Mr. Wright's party was out for sailfish in the boat of Pancho Moreno, well known fishing guide of Acapulco. A 14-ft. hammerhead meant nothing to him, a man accustomed to harpooning whale sharks 18 to 25 feet long and at least twice as bulky as a hammerhead. The 17.5-ft. mounted whale shark skin in the American Museum was from a specimen taken by Pancho. But let us return to our present giant.

Mr. Wright states that the fish and the boat were brought together, but the shark was so large and heavy that it could not be got aboard, and hence it had to be towed ashore, where it was beached, photographed and measured (for length only). It was 14 ft. 2.5 in. in over all length. Unfortunately its girth and other measurements were not taken. It was so long and bulky that it could not be weighed on any scales available. But 24 hours later it was cut into parts, and these were weighed separately. Added up, these equalled 1047 lbs. In addition to the loss of weight by dripping when hung up and by evaporation during the 24 hours, very much more liquid was lost in the capture and in the cutting up—not only blood but other body fluids.

I am satisfied that had the fish been weighed when fresh it would have gone to between 1200 and 1500 lbs.

Strongly to be commended is the good judgment of Mr. Wright and his party in cutting up this great fish and ascertaining its weight by weighing the pieces and adding the separate weights. This is the only big shark known to me of which we have the weight.

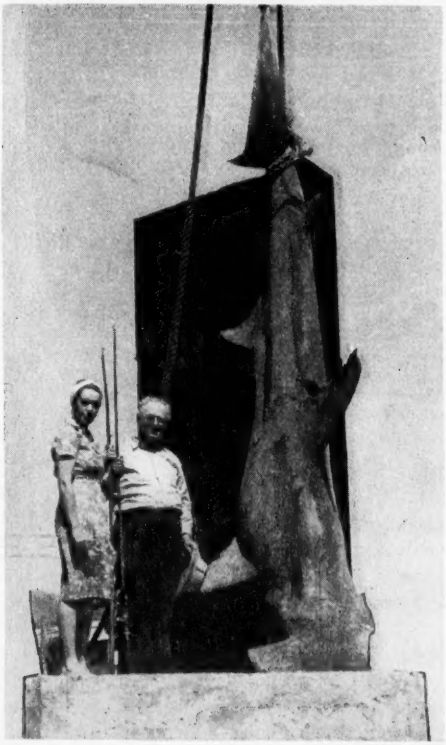

Fig. 2. A 14-ft., 2½-in. *Sphyrna tudes* (?), taken at Acapulco, Mexico, in January, 1940. Photograph by courtesy of Harry Wright.

However, on the second day, and before it was cut up, the great shark was got to a crane used for setting the heavy blocks of concrete used in building a wharf. Here it was hung up by the tail and photographed. Figure 2 shows what a huge brute it was. It is not only longer but much heavier in build than my Beaufort specimen of 1906.

Mr. Wright sent me several pictures of the great shark drawn up on the shore. But taken at a slightly oblique angle they do not show the great length and size of this huge fish. For these one needs a picture taken broadside on. And it is unfortunate that the picture of the shark suspended by

the crane has the anterior part of the head hidden behind the block of concrete. However, comparison of the height of the lady standing on the concrete and of the man standing behind it and on a lower level give one a fair idea of the length of this huge fish.

Noting the heavy "build" of this hammerhead, and the great head and thick hammer (so far as they can be seen) and the relatively high second dorsal, I think that it is probably *S. tudes*. This particular species is found along the west coast of Mexico from the Gulf of California down.

However, judging by its length (14 ft. 2.5 in.) and its weight (1047 lbs.) after much loss of blood and other body fluids, and by a study of its picture (Fig. 2), this hammerhead is surely the largest found so far in this investigation. But one wishes for more definite measurements and weight.

A 15-ft. (?) *Zygaena leeuwini* is the largest Australian hammerhead on record (Ogilby, 1886: 2). Australian waters abound in great sharks and I have sought diligently for accounts of large hammerheads. Even G. P. Whitley knows of no authentic Australian record of one larger than this specimen. Of it Ogilby states that: "The Australian Museum possesses [1886] a mounted specimen [stuffed skin?] of a female which measures over 15 ft.: it was killed at the mouth of the Richmond River in the spring of 1884, and no less than 39 living young were taken from it. Twelve of these, forwarded to the Museum averaged 20 in. each." Whitley sent me this citation and adds: "The specimen is still here but has shrunk to 13 ft., 8 in. long"—as untanned dried shark skins will do.

A 15-ft. (?) *Sphyrna zygaena* (?) was harpooned on March 21, 1919, off Soldier's Key, Florida, by Capt. Charles Thompson of Miami. The Miami Herald of March 22, 1919, states that the shark was "15 feet in length and weighed more than 2000 lbs." But by the time the data had reached Hildebrand and Schroeder (1928, Fishes of Chesapeake Bay: 31), their informant had "raised" the length to 17 feet, and this they published in good faith. However, I have gotten in touch with Mr. Allen Corson, fishing editor of the Herald, who sent me a transcript of the account in his paper of March 22, 1919, which is quoted above. Then Mr. Henry Vanderlei, long a resident of Miami, wrote me that he did not see the great shark weighed or measured, but that he did see it after it had been swung up for photography. He went much further—for he kindly loaned a photograph of the great hammerhead hung by the head and with a grown man standing beside it (Fig. 3). Later, he wrote that he is the man standing beside the fish and that he is 6 ft. tall.

This photographic evidence saves the day. Without it, the accounts, lacking definite evidence of length and weight, would have to be thrown out as unsubstantiated. Using dividers, one finds that the height of the man into the length of the shark, indicates a length for this latter of about 15 feet. However, the alleged weight of 2000 lbs. seems to me much too great. The photograph and weight of this great hammerhead should be compared with the like for the huge Acapulco specimen above. It is a great pity that accurate records of length and weight of this great hammerhead were not made and preserved.

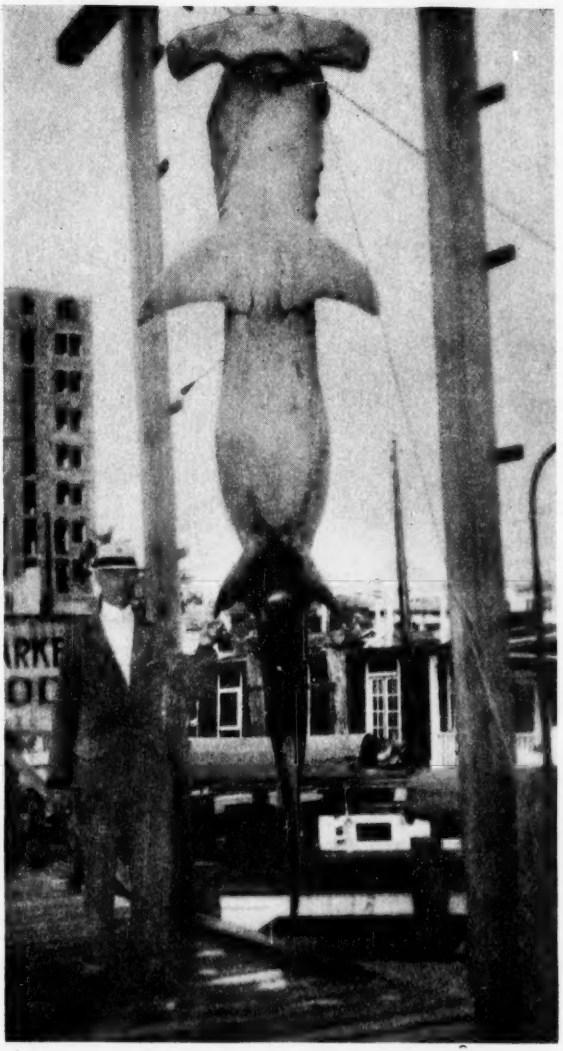

Fig. 3. A 15-ft. (?) *Sphyrna zygaena* (?) captured at Soldier's Key and brought to Miami, Florida, March 22, 1919. Beside it stands a 6-ft. man. Photograph by courtesy of Henry Vanderlei.

Since all the above was written, I have been in communication with Stewart Springer, who is an outstanding student of sharks and particularly of the hammerheads. His connection for a number of years with "Shark

Industries" at Salerno and Stuart, Florida, have given him a more comprehensive knowledge of Florida sharks than is possessed by any other scientific man. He is making a special study of the hammerheads. Of these he kindly writes that the great hammerhead (*Sphyrna tudes*), while not common, is taken fairly regularly in southern Florida.

A 15-ft. 4-in. *Sphyrna tudes* is the largest he has had. It was taken in 50 fathoms off Key West. Other records of *tudes* are: one of 13 ft. 9 in. also from Key West; two of 14 ft. 4 in. from the same locality; and one of 14 ft. 10 in. from Matecumbe Key. These specimens of *S. tudes* are certainly huge hammerheads, the largest measured specimens, not only of this species but of all hammerheads, that have been recorded so far as I can find. It is unfortunate that we do not have more measurements and above all photographs, particularly of the 15-ft. 4-in. specimen.

As noted, Springer is especially interested in the hammerheads and in his present location at the big shark fisheries at Stuart and Salerno, Florida, the hammerheads are especially sought for the high vitamin potency of their liver oil. The specimens brought in give Springer a great opportunity for study, and for recording sizes, etc. Later we may expect from his pen a monographic paper on the hammerheads, for which this little article will be merely a historical introduction.

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Growth of Some Lake Trout, *Cristivomer n. namaycush*, of Known Age in Inland Michigan Lakes

By Vernon C. Applegate

THE lake trout, *Cristivomer n. namaycush*, during the past four decades has been introduced into a number of inland Michigan lakes. The earlier plantings consisting of fry or fingerlings enjoyed a variable, and for the most part, doubtful success. In recent years, a re-introduction of the species using 2-year-old fish was effected in selected lakes then known to possess environmental characteristics favorable to survival. Some measure of the success of these latter plantings with respect to growth, condition and survival was desired, and accordingly certain plantings of lake trout were fin-clipped for future identification. Recaptures of mature survivors of these plantings have not been abundant, but a sufficient number have been recovered to date to present a fairly accurate picture of their growth in three inland lakes.

A search for comparative growth material revealed a striking paucity of age data of any description for the lake trout on record at the present time. A more or less comprehensive study has been completed by Royce (MS)[1] for several eastern lakes in which his age determinations were made by the scale reading method. Cooper and Fuller (1945) give the ages of 244 specimens from two Maine lakes, and Juday and Schneberger (1930) record the ages of 48 specimens from Wisconsin waters, all of which were aged from the scales. Various writers (Eddy, 1941; Greeley, 1936; Neave and Bajkov, 1929; Van Oosten, 1943) have recorded in popular and technical accounts the ages of scattered single specimens and small collections. Growth over known periods of time has been recorded in several instances. Surber (1933) reported on the growth of 2,000 lake trout through their fifth year of life in the ponds of the Lanesboro Hatchery in Minnesota. Smith and Van Oosten (1940) obtained age data on this species based on the returns of tagging experiments carried on in Lake Michigan. Unfortunately, the data they obtained were based on very few specimens. Fry and Kennedy (1937) suggested ages, derived from the modes of a length-frequency diagram, for lake trout of varying lengths from Lake Opeongo, Ontario. Considerable difficulty in aging lake trout by the scale method has been experienced by several investigators working with this species and this may account to a certain extent for the limited amount of comprehensive age data that have been presented (Applegate, MS).[2]

The materials for the present study consisted of scale samples taken from 247 lake trout of known age. Only 89 of these fish were mature specimens. Of the balance, 99 specimens were from sample lots of immature lake trout held in hatchery ponds to determine extent of fin regeneration after clipping; 46 were of a planting sample of 9-month-old hatchery-raised fish;

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1 Royce, William F. (MS). The reproduction and studies on the life history of the lake trout, *Cristivomer n. namaycush* (Walbaum). Thesis submitted to Cornell University in 1943.

2 Applegate, Vernon C. (MS). Comparison of the growth of lake trout as determined from the recoveries of marked fish and by the scale method.

and 13 were of a planting sample of 2-year-old hatchery-raised fish. All samples of fish of known age, with the exception of the 99 specimens held to determine extent of fin regeneration, are related to plantings in three Michigan lakes: Birch Lake, Cass County; Crystal Lake, Benzie County; and Higgins Lake, Roscommon County. The data for each of these lakes will be treated separately.

Birch Lake, Cass County.—Birch Lake is located in the southernmost tier of counties in the state. It has a surface area of 309 acres and is approximately 1.1 miles by 0.8 mile at its greatest dimensions. A maximum depth of 102 feet is known to be present. Plantings of lake trout fry are recorded for Birch Lake for the years 1907–1910. Evidently these plantings failed to establish this species in Birch Lake. None had been reported caught there for many years before 1937, either by angling or in the gill net fishing for cisco permitted there from November 15 to December 10 each year. On November 22, 1937, 9,500 9-month-old unmarked fingerlings were planted. On December 2, 1940, 790 2-year-old lake trout were marked by clipping the dorsal fin and planted. This is known to be the extent of the plantings of lake trout in Birch Lake. Since there is no evidence that lake trout have reproduced in Birch Lake, it is unlikely that any progeny of the 1907–1910 plantings could have been present to be confused with the unmarked planting of November 22, 1937. There have been only 5 recoveries of this latter planting and these are itemized with the planting sample in Table I.

TABLE I

GROWTH OF PLANTED LAKE TROUT IN BIRCH LAKE, CASS COUNTY, MICHIGAN

Date	Known age	Number of specimens	Average weight in pounds and ounces	Total length in inches		
				Minimum	Average	Maximum
1937 PLANTING OF FINGERLINGS						
November 22, 1937	(9 mos.)	46†	...	2.8	3.2	3.9
August 7, 1941	IV	1	...	...	8.3	...
July 12, 1942	V	1	...	...	10.4	...
August 18, 1943	VI	3	...	14.2	15.4	17.2
1940 PLANTING OF 2-YEAR-OLDS						
December 2, 1940	I	13†	...	5.4	6.6	8.7
July 25–August 17, 1942	III	7	0 lb., 10 oz.	11.6	13.0	15.2
July 12–September 5, 1943	IV	10	1 lb., 1 oz.	13.4	15.7	17.7
June 25–November 25, 1944	V	7	2 lbs., 8 oz.	18.7	20.2	21.2
July 7–November 25, 1945	VI	4	4 lbs., 0 oz.	22.4	24.1	25.2

† Sample taken at time of planting.

Recoveries of the marked "2-year-olds" planted on December 2, 1940, have totaled 28 fish to date. Examination of the Oden State Fish Hatchery records established these "2-year-olds" as young-of-the-year in the summer of 1939. Known-age groups have been assigned on this basis. All recoveries and the planting sample are summarized in Table I. The data in Table I

have been projected on a graph and a tentative growth rate curve has been interpolated for the marked lake trout in Birch Lake (Fig. 1). For convenience, total length has been plotted against both a metric and an English scale. Collection dates of recoveries of marked fish were scattered from early summer to fall. August 1 was selected as the mean collection date in plotting the 1942 to 1944 recoveries. The 1945 recoveries are plotted as two collections, each in its proper calendar position, because of the great disparity in time between the first recovery of the year and the remaining three samples which were taken in November.

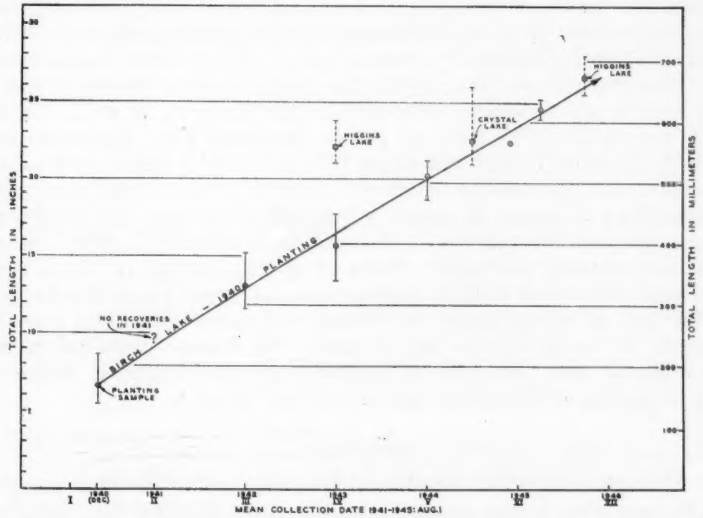

Fig. 1. Growth of lake trout of known age in three Michigan lakes, and tentative growth curve for lake trout planted in Birch Lake.

Crystal Lake, Benzie County.—Crystal Lake is located on the western margin of the northern half of the Lower Peninsula of Michigan adjacent to Lake Michigan. This lake has an area of 9,711 acres and a maximum depth of 162 feet. In May and June, 1941, 7,335 "2-year-old" lake trout were planted in Crystal Lake. Of this total, 2,000 were fin-clipped (dorsal) at the time of planting. Examination of the Harrietta State Fish Hatchery records has established these fish as young-of-the-year in 1939. Known ages have been computed on this basis.

There is only one collection of marked recoveries from this planting. It consisted of 48 fin-clipped lake trout taken from the lake between February 19 and March 3, 1945. These trout were all entering age group VI and their seventh season of growth. They averaged 22.8 inches in total length with a range of 21.0 to 26.0 inches. Weights had been taken for all specimens. They averaged 3 pounds, 13 ounces (3.8 pounds) with a range of

2 pounds, 8 ounces to 5 pounds, 15 ounces. The average length and range in length of these specimens have been plotted in Figure 1 for comparison with the same age group of the Birch Lake material. The chronological and age-group scale plotted along the base of Figure 1 is valid for the Crystal and Higgins Lake material as well as the 1940 planting in Birch Lake.

Higgins Lake, Roscommon County.—Higgins Lake is centrally located in the northern half of the Lower Peninsula of Michigan. It has an area of 9,600 acres and a maximum depth of 141 feet. On May 24 and June 3, 1941, a total of 4,165 "2-year-old" lake trout were planted in Higgins Lake. The records indicate that the entire planting was marked by clipping the dorsal fin. In the records pertaining to the Crystal Lake plantings, previously discussed, the age at planting and year class (young-of-the-year, 1939) were established as identical for the plantings in both Crystal and Higgins lakes.

Nine recoveries of these marked lake trout have been received to date. Six were recovered between September 16 and November 18, 1943. These fish were in their fifth season of growth (age group IV). They averaged 22.2 inches in total length and ranged from 21.1 to 23.8 inches in the same measurement. Their average weight was 3 pounds, 13 ounces, and individuals ranged from 2 pounds, 14 ounces to 4 pounds, 11 ounces. The remaining three specimens were recovered between April 29 and May 7, 1946. These fish were entering their eighth season of growth (age group VII). They averaged 26.6 inches in total length and ranged from 25.6 to 28.0 inches. They had an average weight of 5 pounds, 15 ounces and varied from 5 pounds, 6.5 ounces to 7 pounds, 0 ounces. The average length and range in length of these two groups of specimens have been plotted in Figure 1 for comparison with the Birch and Crystal Lake materials.

Discussion

Although recoveries of specimens of known age are not abundant enough to be conclusive, it does appear from the material available that the lake trout in Crystal Lake were growing at a rate comparable to that of the trout in Birch Lake. This conclusion is based on the assumption that all age groups approximated each other as closely in average total length as did age groups VI in both lakes. Average weights of the fish in age group VI from both lakes were similar and we may conclude from these data that there was little difference in the "condition" of the lake trout from the two bodies of water. If the small collection of marked fish taken in Higgins Lake in 1943 was a fair sample of the marked lake trout remaining in the lake at that time, it would indicate that fish of the 1941 planting enjoyed a markedly accelerated growth rate during their first two seasons in the lake (Fig. 1). In their fifth season of growth, the specimens recovered had the same average weight as those taken from Crystal Lake that were in their seventh season. They were exceeded by the latter by only 0.6 inch in average total length. However, the small collection taken in 1946 reflects a deceleration in growth rate. In their eighth summer fish of the Higgins Lake planting had attained an average length similar to that of the same age groups in Crystal and Birch lakes.

There is an appreciable disparity in the rates of growth of the 1937 and the 1940 plantings in Birch Lake, indicating that for some reason the 1937 planting had some difficulty in maintaining itself. In view of the satisfactory growth rate of the 1940 planting, it is difficult to ascertain just why this should have occurred.

In general, these marked lake trout in the three lakes exhibited a rate of growth comparable with those populations studied from New York and Ontario waters (Royce, MS) and with Surbers' (1933) hatchery-raised fish. Their growth was measurably better than that reported by Juday and Schneberger (1930) for lake trout in certain Wisconsin waters, by Greeley (1936) for the same species in Otsego Lake, New York, and by Cooper and Fuller (1945) for togue (lake trout) in two Maine lakes.

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Trends Towards Non-Aquatic and Direct Development in Frogs

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THE study of the life-cycle of the Amphibia Salientia has been relatively neglected compared to other aspects of work upon them, such as taxonomy. This can only be attributed to the circumstance that most herpetologists interested in frogs live in the temperate zones of the world, where the species are relatively few and fairly uniform as to life history. In the tropical and sub-tropical belts the number of forms is considerably increased and a greater variety of life history obtains. There, visiting or resident naturalists have discovered a number of exceptions to the rule of spawning in water and undergoing a free-swimming larval stage before metamorphosis into adult shape.

Not the least striking, and probably the best known, is that of the genus *Pipa* in which the female carries her eggs in individual chambers in the dorsal tegument, out of which the young hatch as minute adults (Maria Sybille von Merian, 1705; *see* Werner, 1912; Laurenti, 1768; Wyman, 1854; Sclater, 1895; Barlett, 1896). Many other exceptions have been described since. Some of them exemplify apparently simple methods of parental care for the young. Male *Dendrobates* and *Phyllobates,* for instance, transport their tadpoles on their backs (Wyman, 1857, 1859; Kappler, 1885; 1887; Cope, 1887; Smith, 1887; Boulenger, 1895; Ruthven and Gaige, 1915; Dunn, 1924, 1926, 1931, 1940, 1941; Eaton, 1941; Breder, 1927, 1946). The female *Leptodactylus ocellatus* guards her very immature tadpoles (Fernandes, 1921). Other changes are more radical, such as the development of the larvae of *Rhinoderma darwinii* in the vocal sac of the male (Espada, 1872; Howes, 1888; Buerger, 1905; Krefft, *see* Werner, 1912; and Pflaumer, 1934).

Information on these and similar facts is largely scattered in papers on species from diverse zoological regions. There have been relatively few attempts to carry out systematic observations in the same place, over long periods, a method which, though slow and somewhat dependent on chance, is the most likely to uncover other unusual and perhaps intermediate life histories.

Noble did excellent work on the relations between ontogeny and phylogeny (1925) and on the value of life history data (1927). There is still need, however, for further observation. Moreover, the known facts call for an overall consideration, with a view to ascertaining whether they form an evolutionary sequence, leading from full aquatic larval life to direct development, such as that of the Sauropsida.

During many years of field-work in southeastern Brazil, much of it in the rain-forest of the Maritime Range near Rio de Janeiro, my father, the late Professor Adolpho Lutz, our assistant, Mr. Joaquim Venancio, and I have had the opportunity to observe many interesting life histories. Some were already known but others were seen for the first time. A summary of

these life histories is given here very briefly and at slightly greater length only when the observations are new or the details have not been published before. These changes of ontogenetic development do not form one single linear series, nor do they all occur in the same taxonomic groups. They do, however, exhibit diverse and increasing deviations from the usual salientian ontogeny.

Observations

In the family Hylidae, or tree-frogs, the frogs of the genus *Hyla* generally lay large complements of very small eggs, in gelatinous masses, in water. The larvae hatch in a very embryonic stage, hardly reacting to tactile stimulus. In Brazil this may occur within 24 hours, as I have observed even in the large species *Hyla mesophaea*.

Hyla decipiens (Lutz, 1924, 1936), which is very small, presents a slight deviation from this rule. It spawns on the leaves of the vegetation overhanging still and sluggish waters. The gelatinous mass droops and releases the larvae. On one occasion, over 30 clutches were found by Professor Lutz, Dr. Doris M. Cochran, and Mr. Venancio, and the tadpoles were reared in the laboratory until metamorphosis. On another, 7 clutches were found by me. In this instance the larvae hatched during transportation. They were 2.5 mm. long in head and body, with 4 mm. of tail. Their eyes were formed and they had external gills but they still showed the pair of cement glands at the sides of the stomodaeum. This species exhibits some other interesting features, such as nuptial excrescences at the base of the first finger of the tiny males (often only 21 mm. long) and variability in the presence or absence of vomerine teeth.

Some other hylid genera lay few and relatively large-yolked eggs, outside water. *Centrolenella,* for instance, spawns on the open surface of leaves. We have followed the life history of *Centrolenella eurygnatha* (Lutz 1924, 1926), which breeds above mountain brooks, sometimes near water falls, where the eggs can take up moisture from the spray. The largest complements seen contained 26 and 30 eggs, but more often there is not much more than half that number. They are laid on the upper or the lower sides of the leaves on which the adults often sit. The egg mass is about 35 mm. long and from 20 to 25 mm. in width. The gelatinous egg-membranes are ill-defined and appear confluent. The eggs are a light, greenish-cream and very young embryos are of the same colour as the yolk. Intra-oval development lasts 2 weeks, during which time long external gills develop for a while. As ontogeny proceeds the larvae become very elongate and form a ring inside the membranes. At the time of hatching they straighten out, break through the membranes and glide or fall into the water, sometimes 2 or more yards below them. They are perfect tadpoles 10 mm. long, with only 2.5 mm. for the head and body, and have some yolk in the gut. The adults are between 20-26 mm. from snout to vent.

These tadpoles have not been raised right through as their requirements are difficult. They are, however, quite characteristic when they hatch and have been matched with older larvae; metamorphosing specimens have also been caught. Within their mountain stream habitat they are adapted to life

in the small, still, reaches where dead leaves and other detritus accumulate. They have very minute eyes under the skin, and are also almost devoid of pigment, except for a few gray dots which appear in the encapsuled larvae exposed to light. Later, they become burnt orange or dark wine-red, or occasionally pink. They remain very elongate with narrow tail and fins. When disturbed, they swim with rapid undulating movements, seeking cover again. The upper lip is long and juts out; it may be used to push through the sand in the bed of the streams. The lower lip is provided with a fringe of elongate papillae. Metamorphosing specimens become suffused with light green and the long bones of the developing limbs also show this colour. The adults are a translucent pea-green with the internal organs visible.

These observations confirm Breder's supposition that 2 clutches of eggs collected by him in Panama (Breder, 1927, 1946; Noble, 1925, 1927) belonged to *Centrolene fleishmanni.* Dunn (1931) also has confirmatory data.

Phyllomedusa goes a step further, as already known. While spawning the parents fold up the single leaves on which they lay and glue the edges together with their feet (Budgett, 1899; Bles, 1905), or build a nest by glueing several leaves together (Ihering, Boulenger, 1886; Mole and Urich, 1894), using small unyolked eggs for capsules for this purpose (Agar, 1909). We have confirmed this and the habit of folding up single leaves for two of the small species seen in this region (Lutz and Lutz, 1939) and probably for the large species, *P. burmeisteri,* to judge by the size of some of the clutches collected.

The spawning of *Phyllomedusa guttata* (Lutz, 1924, 1926, 1939) was observed by me on November 2, 1946. The night before, a pair was caught in the Tijuca Mountains, while the male called and the female approached. They were brought to the house and released on a plant from their own environment, potted for the purpose and put within sound of running water. They had then already gone into axillary amplexus and remained so until after spawning, some 24 hours later. During the remaining hours of darkness of the first night, the female wandered around a good deal, with the male sitting on her back. The next day, they were apparently lost for some time, having hidden behind a dark vial. The following night, after more wandering, they settled, about ten o'clock, on the upper side of a leaf. The female sat very straight, in a line with the median rib, her fore arms held parallel to and above her head, while her feet passed onto the lower side of the leaf, which the male could not have reached. (The female was 46 mm. and the male only 35 mm. long). While spawning, they moved slowly up and folded the leaf as they filled it. As usual, the two ends were left unfolded. The lower opening, near the tip, corresponds to the initial position of the mated pair and the upper, near the stalk, to the hole through which they leave after finishing. As soon as they had done, the male began to cluck softly (the mating call is a sharp double cluck) and left the female, who remained in the same position for another 30 minutes. Budgett observed and timed the spawning of *Phyllomedusa hypochondrialis* in Paraguay (1899) with approximately the same results, but states that spawning sometimes continued on another leaf.

Fig. 1. *Hyla goeldi* with egg mass, sitting on a bromeliad leaf turned outwards. Photographs by J. Pinto.

Fig. 2. *Hyla goeldi* with mass of over twenty eggs on her back. Natural size of mother 38 mm.

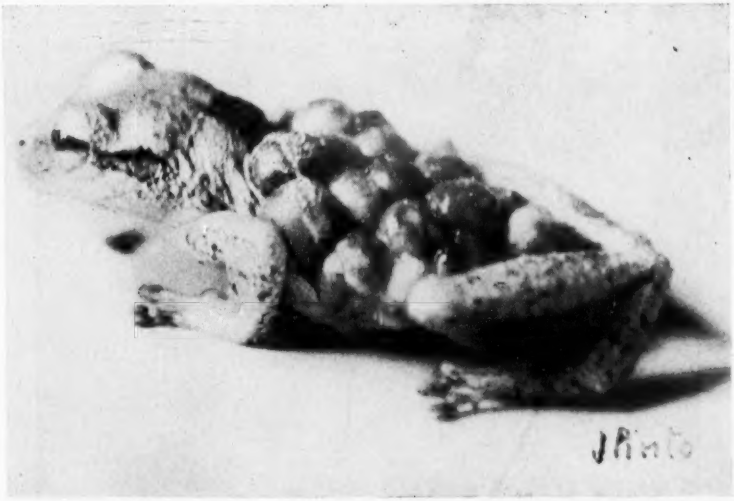

Fig. 3. *Hyla goeldi* with mass of about twenty eggs on her back. Natural size of mother 38 mm.

Fig. 1. Nest of earth built by *Leptodactylus nanus*, with an opening left in the roof.

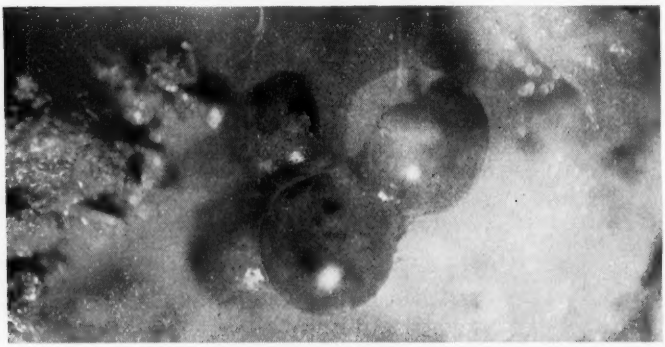

Fig. 2. *Eleutherodactylus parvus* eggs, with one specimen just emerged.

Photographs by Gualter Lutz.

Fig. 3. Terrestrial larvae of *Zachaenus parvulus* in their earthen nest.

Though watched throughout most of the night my pair showed no tendency to continue and I believe that the supply of eggs was exhausted. The clutch was kept on the plant and guarded against marauding insects.

A fortnight later, November 15, 46 perfect tadpoles hatched; 2 dead and defective ones, a spoilt egg and some gelatinous remnants were recovered from the leaf. The larvae were at a perfect tadpole stage with lungs and all their sense organs; even the dorsal oral funnel, which is used as a float, was present. *P. guttata* is a mountain stream species and had to be raised under artificial conditions. Great differences in size and vigour soon became apparent, and the specific gregarious habit of swimming in schools was less in evidence. The first tadpole to metamorphose transformed in 3 months and others continued to do so for many weeks. Field observations suggest that the first period was probably the nearest to normal.

The female coelonotous Hylidae carry their large-yolked eggs on their backs in a single mass. In the large species of *Gastrotheca* there is a median dorsal pouch (Weinland, Boettger, 1893; Brandes & Schoenichen, 1901; Werner, 1912; Gaige, 1922). In some of the medium sized forms, a rim forms at the sides of the egg mass (Goeldi, 1895; Boulenger, 1895); in others there are folds over it, encasing it more or less completely, except in the middle, where there is an irregular, sometimes interrupted, longitudinal opening (Miranda Ribeiro, 1920, 1926; Parker, 1933).

In the small and medium-sized species observed by us the large ovarian eggs can be seen through the translucent wall of the abdomen. Meanwhile, the skin of the dorso-lateral region gradually becomes distended, as if forming a pair of air cushions or sacs, which later somehow get folded over, or to the sides of the egg-mass, possibly by the male during amplexus. After the tadpoles leave their mother's back these bags are again visible but deflated and soon disappear. No vestige is left of the contact of the eggs with the maternal skin.

The complement of eggs varies with the size of the mother and of the species to which she belongs. In the small specimens of the small species of this region it may be only 7 or 9, in larger females 13. Large females of a middle sized species, *H. goeldi*, about 38 mm. long, may carry 20 to 25 eggs on their backs. Intra-oval life lasts from 2 to 3 weeks in the small to medium sized regional species. When not covered by pigmented and patterned skin, early phases of development, such as the formation of the network of blood-vessels over the yolk, are quite perceptible. Later phases are obscured by the development of pigment inside the eggs. They comprise the formation of bell-shaped gills. Hatching occurs at a stage when the hind limbs are formed, with or without perfect digits, and the gills are still present but very much reduced. There is much yolk in the gut.

As hatching approaches the mothers often sit in the water. The tadpoles may emerge one by one, as I have seen in *H. goeldi*. In small species, or specimens, with only a few eggs, these are disposed in a rosette, because the rows are shorter on the periphery. The rosette may come off entire. The tadpoles are then seen struggling inside the egg-membranes, setting the rosette into whirling motion. They emerge tail first. A few days later, the elbows

begin to distend the skin over the branchial chamber and metamorphosis is complete at the end of 10 to 15 days, according to the species. During their short period of larval life the tadpoles often stand on their heads below, and also come up to the surface repeatedly.

Some of the large species are stated to carry about 100 eggs and to complete development within the pouch.

All the coelonotous Hylidae, large or small, that I have collected were found in bromeliads, with one exception. This one, tentatively referred to *Hyla ohausi* Wandolleck (1907) (on the advice of Helen T. Gaige), though the morphological characters do not combine quite perfectly with the description, is adapted to life inside a bamboo. We discovered this habitat in Theresopolis, at 1000 m. altitude. The bamboo housing the frogs is a large species with transverse septa. The hollow segments of the shafts often hold water and sometimes show apertures. These range from minute punctures, probably drilled by insects, to bigger holes, perhaps enlarged by woodpeckers or occasionally torn by monkeys, both presumably in search of coleopterous larvae. Now and again traces of cutting by axes are visible. We had already seen the frogs a number of times and had even caught all stages from tadpoles with hind limbs to adults, inside one of them, when we found a female with 7 eggs on her back. She was 31 mm. long. The tadpoles hatched a few days later while she was being photographed. They were very shapeless and distended with yolk and the only survivor remained 15 days in the water, which seems too long for the size, so hatching may have been premature.

The Neotropical representatives of the aglossal toads (Pipidae), which carry their eggs in individual chambers in the dorsal skin of the mother, are phylogenetically unrelated to the tree-frogs. (Their nearest relative, the African *Xenopus,* follows the usual course of development.) *Pipa* is found in the water-logged Amazonian Hylaea, where a continuous sheet of shallow water may extend for miles under the forest.

A totally different and very interesting mode of development occurs in two closely allied Neotropical genera of Leptodactylidae, *Cyclorhamphus* and *Thoropa,* which have undergone secondary ecotopic divergence.

Thoropa lives on the constantly wet portions of the more or less vertical outcrops of rock, which are a marked feature of the Brazilian orographic system. *Thoropa petropolitana* and its tadpoles were described by Wandolleck (1907). The tadpoles are elongate, narrow, lunged, and non-aquatic. They glide along the slimy rock surface, clinging with their horny beaks. On the same rocks I have found their spawn, which consists of relatively few and large-yolked eggs. *Thoropa miliaris* Spix is larger and more robust. The adults roam farther afield, but the larval habits are the same as in the other species. All stages exhibit protective resemblance (Cott, 1941), especially perfect in *Thoropa petropolitana.*

Cyclorhamphus has become adapted to more or less troglodytic ways of life. Lutz (1928, 1929) studied the life histories of two species, *C. juliginosus* and *C. pinderi,* which live in crevices of stone in mountain brooks and streams and in grottos beside them. The eggs are laid on ledges of rock over which water trickles or falls in a thin sheet. The larvae hatch with eyes, yolk in

the gut and a rudimentary operculum. They can swim energetically but hold the anterior part of the body out of the water. They also adhere to wet rock-surfaces. Those of *C. pinderi* climb up the sides of water falls. We have seen this species guarding its eggs in a grotto.

Other instances of this mode of life history are not known. Similar ecotypes must exist elsewhere though they have not been investigated. The *Borborocoetes* (of authors) of the Andes are phylogenetically very closely related to these genera but nothing is known of their life histories. The breeding habits of *Eleutherodactylus latrans* of North America also need to be investigated. It is said to have tadpoles, which are unknown in the genus *Eleutherodactylus,* and morphologically it is very smiliar to the larger *Thoropa.*

Cyclorhamphus has undergone considerable adaptive radiation, some species becoming fully aquatic and living under stones in brooks, while others are more or less terrestrial and fossorial. The life histories of these species are not yet known but there are good reasons for expecting them to show further diversification leading to direct or at least to terrestrial development in the burrowing forms. *Craspedoglossa bolitoglossa* is stated by Miranda Ribeiro (1926) to develop within the egg but this and its exact generic status need further investigation.

The entirely terrestrial development of *Zachaenus parvulus* (*Oocormus microps*), which seems to be intermediate between *Cyclorhamphus* and *Ceratophrys,* was observed and described by me (1944). The relatively large eggs were laid in a small hollow in a bank of earth, some yards away from water and had no cover except a few dead leaves. The tadpoles that hatched showed some of the features described below for *Leptodactylus nanus.* They crawled around in their earthen nest but never went into water and did not try to swim when placed in it. The yolk in the gut lasted for 13 days after metamorphosis.

A polyphyletic change in the development of tropical frogs consists in surrounding the eggs with froth. In the Old World it is seen in certain genera of the Rhacophoridae which, according to Noble, are derived from the Ranidae and are mostly tree frogs (Noble 1924, 1927, 1931; Bhaduri 1932).

In the Neotropical region this habit is exhibited by certain Leptodactylidae. They comprise several genera of relatively small frogs, separated off from the former genus *Paludicola,* and the genus *Leptodactylus,* which replaces *Rana* in the New World. The froth is produced by beating up gelatin with the feet while spawning (Hensel, 1867; Budgett, 1899; Bles, 1907). The adults are ground-dwellers with a wide range of spawning-sites. The small paludicolas, *Physalaemus* (Fernandes, 1921, and other authors) and *Eupemphix* (Lutz, 1927: Breder, 1927, 1946; Netting, 1930) leave their little packets of froth in or at the edges of small pools and puddles. The large species of *Leptodactylus, L. pentadactylus* (Breder, 1946) and *L. flavopictus* (author's unpublished observation), deposit huge masses of froth in rather shallow pot-shaped holes. A medium sized species, either *L. mystacinus* or *L. mystaceus,* was seen by Hensel (1867) to spawn in depressions not in

but near water and likely to be flooded. *L. mystaceus* is gregarious. Mr. Venancio and I found the nests of a number of adults built around hollows that contained semi-permanent water, likely to increase during rainy weather. The nests were built of earth around the roots of grasses and were above water-line but open below. Hatching was induced in the laboratory by flooding some of them from beneath.

Leptodactylus nanus, including *L. trivittatus*, which is probably a colour-phase, shows an interesting development, first described by my father (Lutz, 1931) and later observed with more detail by me. It scoops out small pans of earth, in sites distant from water, in which to lay the eggs, which are surrounded by froth as in the other members of the genus.

The pans are carefully smoothed inside and sometimes show traces of work with narrow instruments, probably the toes. When intact, they have slightly elevated, more or less dome-shaped roofs, with a small aperture in the middle. This is probably the exit by which the adults leave after spawning and the young after metamorphosis. Unfinished pans have been seen and also finished but unfilled pans, once with a frog, and once with a pair sitting in them. The pans are 24 mm. deep and about 35 mm. in diameter. When the froth is new it is compact. In older spawn-masses the imprisoned air-bubbles are larger and the surface becomes concave. Towards the end of development the froth seems to decrease rapidly.

This species undergoes the whole of its ontogenetic development inside these nests. There are generally 8, sometimes 9 or 10 eggs, with hyaline membranes, which look like unbeaten egg albumen, in the middle of the froth. They are about 2.5 mm. in diameter, with cream-coloured yolk. The embryos form on top of the yolk and are surrounded by a disk. At an early stage a network of blood-vessels forms over the yolk and the embryos lie on their backs. External gills appear for a time, then involve. In later phases the tadpoles are pigmented and tend to hide under the froth. When the legs are formed but the tail is still long, they sit very upright in the nest, which they leave only after metamorphosis. They already show troglodytic habits, returning to the empty nests during the first days.

This species is very plentiful round Rio and can be heard calling all the year round in the gardens of residential districts and on the slopes leading to the mountains. Where conditions are favourable, such as in undisturbed garden-beds with loose creeping vegetation, many individuals are found close together. In one garden undergoing remodelling, 7 frogs were taken from one flower-bed. On another day, 7 earthen nests, one empty, the others full, were found along a linear stretch 2½ meters long and on still another occasion 16 full and more than that number of empty nests were gathered from a kidney-shaped bed, with an area of about 27½ square meters.

In all the frogs mentioned above, the larval period has been shortened and has become partially or entirely non-aquatic. In the genus *Eleutherodactylus* it is altogether omitted (Bello y Espinosa, 1871; Bavay, 1873; Peters, 1876; Sampson, 1900, 1904; Ruthven, 1915; Dunn, 1926, 1931; Noble, 1925, 1927; Lynn, 1942; Lutz, 1944; Gitlin, 1944, etc.). One group of species shows external gills for a time but in another group they never de-

velop. This is true in two forms occuring in this region (Lynn and Lutz, 1946, 1946a). One of them, *E. guentheri,* buries its eggs in small hollows, like miniature roofed caves, in banks of earth, and the other, *E. nasutus* (Lutz, 1924, 1926), spawns in the outer leaves of bromeliads. In early stages a network of blood-vessels forms over the yolk. At a later stage, the tail develops greatly, becomes vascular and thin, and is closely applied to the egg-membranes. It seems to be the main respiratory organ. Intense circulation can be watched in the capillaries. After hatching, the tail is absorbed rapidly.

In the Paleotropical region direct development occurs in *Discodeles opisthodon,* a ranid, and in the brevicipitid, *Oreophryne.*

These examples show that the Neotropical life histories of Salientia run more or less parallel with other frog life histories from the Paleotropics (*see* earlier biblography in Brandes and Schoenichen, 1901; Werner, 1912; and Noble, 1925, 1927, 1931; more recent literature is not within my reach). Detailed comparison might bring out interesting points but, unfortunately, the data available are insufficient for this purpose.

Two ovoviviparous species of frogs have been reported from Africa by Tornier (1905) and Krefft (1910), but thus far no ovoviviparous salientians are known from the New World.

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Rectilinear Locomotion in Snakes

By C. M. Bogert

IN his recent paper dealing with the mechanism of locomotion in snakes Gray (1946: 101) recognizes four main types of terrestrial progression among serpents. Three of these, termed (1) serpentine, (2) concertina, and (3) sidewinding, respectively, were described on the basis of observations made on the European grass snake (*Natrix natrix*). The fourth type, somewhat inaptly called caterpillar movement by Mosauer (1932: 585), is referred to as rectilinear movement by Gray. It was not observed in *Natrix*, but Gray notes that "This type of locomotion depends on active movements on the part of the ribs and the ventral scales."

Despite Mosauer's observation that "the ribs are not employed in the sense of the 'rib walking' theory," the notion appears to be prevalent that rectilinear movement, in which the snake progresses with its body oriented along a straight line, is dependent upon movements of the ribs. It was formerly a textbook cliché that "snakes crawl on their ribs" and sometimes the snake was even compared to a centipede, with the implication that the ribs correspond in function to the legs of the latter. Not having observed rectilinear movement in the grass snake, Gray may have been misled by some of the accounts of snake locomotion that preceded Mosauer's. At any rate his impression is a false one.

Rectilinear movement is quite impossible for such snakes as *Coluber*, which have the skin on the venter firmly attached, but it is characteristic of *Bitis*, *Crotalus*, and other thick-bodied venomous snakes when they are prowling. The sidewinder (*Crotalus cerastes*) is a notable exception, although even this specialized rattler occasionally resorts to rectilinear movement in its natural habitat (as may be seen from the tracks) and commonly does so when moving along the edge of a cage under captive conditions. The ventral scales are raised in some sections of the body and carried forward, sometimes dragging over the loose sand, while those in other portions of the body are resting on the substratum. The ventrals carried forward are then anchored in the sand, and the snake's body is drawn forward by muscular action to rest on these sections of the body, while the alternate series of ventral scales are, in turn, slightly raised and carried anteriorly. Thus, by moving alternate sections of the venter forward, and by means of muscular action drawing the body over the ventral scales resting on the substratum, the snake is able to draw its body forward in a straight line. Rectilinear movement is dependent upon the muscles connecting the ribs to the integument, and on the elasticity of the skin, the ventral scutes of which serve as a sort of telescoping tread, segments of which are connected by cutaneous muscles, as well as by connective tissue.

But there is no "active movement of the ribs." The muscles controlling the successive waves in the ventral scutes are attached to the ribs, but the ribs themselves remain stationary with reference to the vertebrae. This can be ascertained by cutting a window in the skin of the live snake just above

the ventral scales on one side. As the ventrals are first drawn together and then stretched apart it can be seen that the body of the snake, rigidly supported by the ribs, slides forward over the stationary scutes. These, in turn, are slightly raised from the substratum and moved forward, without any movement on the part of the ribs.

Although Mosauer recognized but three principal methods of snake locomotion, Gray is able to distinguish four since he includes "concertina movement." This was briefly mentioned by Mosauer, who commented somewhat obscurely that "Finally, snakes can move by alternately bending and straightening portions of their bodies." Gray's analysis of snake locomotion is an improvement over Mosauer's, but some of the changes in terminology suggested by Gray appeared to be unwarranted. "Horizontal undulatory" is a better term than the ambiguous "serpentine movement," used by Gray, and "crotaline" is not especially apt for "sidewinding," the term long in use and accepted by Mosauer.

Sidewinding is characteristic of the snakes in the genus *Aspis* (formerly known as *Cerastes*), and it is probable that snakes belonging to the genus *Pseudocerastes* utilize the same method of locomotion. *Bitis caudalis* and *B. cornuta* of the Kalahari Desert are other possibilities, although no observations on the locomotion of these viperids appear to have been reported. When forced to move rapidly on a flat surface even *Bitis arietans* resorts to sidewinding, but it is a crude performance compared to that of *Crotalus cerastes*. Racers (*Coluber* and *Masticophis*) are unable to sidewind, although a rough approximation of this type of locomotion is commonly seen in garter snakes (*Thamnophis*), as well as in a few of the smaller North American colubrids. A Cuban boa, *Tropidophis melanurus*, however, is a far more capable sidewinder than any colubrid that I have seen. *Natrix natrix*, to judge by Gray's diagrams, sidewinds in much the same fashion as *Thamnophis*. To call this method "crotaline movement," implies that it is characteristic of the pit-vipers, whereas it is well developed only in *Crotalus cerastes* among the crotalids; most of the rattlesnakes are no more adept at sidewinding than *Thamnophis*.

The chief purpose of this note, however, is to point out that a snake does not, except in the loosest possible sense, "travel on its ribs," although this statement appears in one handbook published as recently as 1945. Gray's careful analysis of the kinematics involved in snake locomotion fully warrants the recognition of four main types, preferably termed (1) horizontal undulatory, (2) concertina, (3) rectilinear, and (4) sidewinding.

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Second Report on Herniation in *Hyla aurea*

By Laurence R. Richardson

In 1943, I reported (Richardson, 1943) a case of external herniation of the oviduct in a specimen of *Hyla aurea*. Since that time much more material has passed through our laboratories, and an additional two cases of external herniation have come to hand. The laboratory records of dissection material are not complete over the past seven years, but at least 900 specimens have been dissected in this time and the incidence of herniation can be set at approximately 0.3 per cent as observed by us in this species. This contrasts with an absence of such cases in my Canadian experience, in which more than 1,000 *Rana pipiens* and at least 400 *R. catesbeiana* from unselected trapped specimens passed through the zoological laboratories at McGill University, and where much additional material came under my personal observation. These herniations are not minor abnormalities, which might be overlooked, but are gross and readily detected.

In the present two specimens one is a male with herniation of the genital fat-body in a manner similar to that of the oviduct initially reported. The other is peculiar since the herniated structure can only be classed as a cystic ovary and the site and process of herniation are distinct from the other two cases.

The latter specimen is a medium-sized female, 60 mm. in length from the tip of the nose to the free end of the urostyle. There is a gross swelling extending from the axilla almost to the hip on the right side of the body. The margin of the body on this side is 22 mm. from the midline; on the other, 13 mm.; the swelling is thus 10 mm. in height. The base is 23 mm. The swelling is soft and fluid to the touch. The skin covering the swollen region is stretched so that the pavement-like patches marking the skin in this area are extended to measure 2.0 mm. to 3.0 mm., in contrast to the normal 0.75 mm. to 1.5 mm. of the other side.

On dividing the skin over this region, a thin-walled fluid-filled sac is exposed. The sac extends throughout, and fills the lateral abdominal lymph space. It is fastened to both the body-wall and the skin by numerous adhesions and contains at least 50 unpigmented eggs of a variety of shapes, obviously in process of necrosis. Freeing the sac from its adhesions, it is found that the sac emerges through an ill-formed opening at least 5 mm. in diameter, bounded by the posterior margin of the M. obliquus externus anteriorly and perforating the M. obliquus internus and the M. transversus abdominis. The aperture is for the greater part blocked by a coil of the heavy, thick-walled oviduct, which does not follow the sac into the lymph-space.

The abdominal cavity is virtually filled by two large sacs, both containing a thick, clear mucous fluid in which there is a large number of eggs in a condition similar to those seen in the herniated sac. The anterior large sac has a restricted connection to the anterior end of the right ovary; the posterior sac, which is continuous with the herniated sac, is connected to the

posterior end of the ovary in the same fashion. The left ovary is normal, containing well-pigmented healthy eggs ranging up to 1.75 mm. in size. This ovary extends almost the length of the abdomen as a thick, loosely folded lamella. The right ovary is shorter, restricted to the posterior two-thirds of the abdomen, of a form and containing eggs similar to the opposite ovary. The oviducts have commenced hypertrophy, the walls are swollen and the coils compact.

The anterior sac has a capacity of nearly 7.0 c. cm. and hangs freely in the abdominal cavity. The membranous wall is strong, partially pigmented, and extends into the lumen of the sac as short, incomplete septa. The posterior sac is similar but of a slightly smaller size, and free in the abdomen excepting where it is held to the body-wall by the portion which is herniated.

These sacs with their contents must be considered as cystic developments of the ovary. The condition of the ovaries is similar in both except for the cysts. In the cysts, the ova are far larger than in the normal ovarian tissue. The fluid of the cyst is of interest in being clear but highly viscous. In many respects, these cysts resemble a compound ovarian cystoma, fitting well with the definition of that condition when due allowance is made for the distinctions which must exist in view of the less complex histology of the ovary in the amphibian.

Pressure from the posterior sac has resulted in atrophy, local functional failure and perforation of the Mm. abdominis transversus and obliquus internus by the sac, which has continued its path to the lateral abdominal lymph-space by passing posterior to the margin of the M. obliquus externus. Unfortunately it is not possible to determine with certainty the fate of the peritoneum. In the herniation of the oviduct reported previously, the peritoneum was carried ahead of the herniated organ. In this case, so far as it is possible to see, the peritoneum has been perforated, certainly the outer surface of the ovarian cyst in the abdomen has the same appearance as has the surface of the herniated portion and no continuity can be demonstrated between the latter surface and the peritoneum of the abdominal wall.

The male specimen measures 64 mm. from the tip of the nose to the free end of the urostyle. On the back there is a low mound, 13 mm. long by 8 mm. wide, commencing at the level of the sacrum and extending obliquely and to the left from the mid-line to a point on the level of the middle of the urostyle. When the skin is reflected, the mound is seen to consist of a bean-shaped mass of golden-yellow fatty substance held firmly in place on the back muscles and resting in the dorsal lymph-space. The surface is covered by a smooth sheet of tissue which splits readily into two layers: the outer, which can be followed as continuous with the tissue lining the lymph-space; the other, continuous with the dorso-lumbar aponeurosis. In the 'hilum' of the mass, there are five small vesicles of 1 mm. diameter, and clear yellow. These contain fat. On dividing the covering sheets, the mass is found to be a single entity enclosed in a third extremely delicate sheet of tissue (later found to be continuous with the peritoneum). This inner-most layer is bound by multiple adhesions to the body-wall. When the adhesions are

cleared the main body is seen to rise from a flattened stem, 3.0 mm. by 1.0 mm., of a similar substance to the main mass. This stem passes through a perforation of the same size and shape in the body-wall where it is continuous with a flattened, elongate, narrow lobe rising from the dorsal aspect of the testicular fat-body. The fat-body has its origin on the dorsal surface of the anterior third of the testis, which is cylindrical, and measures 1.2 cm. by 0.4 cm. The fat-body as a whole is flattened, 1.8 cm. in length, and averaging 0.3 cm. in thickness. The outer surface is convex and follows the curvature of the wall of the abdomen. The mesial surface is concave, moulded about and applied to the dorsal and lateral aspects of the descending limb of the stomach. The fat-body commences as a short, narrow, flattened portion that continues laterally and expands into the main portion of the fat-body. This is a large, complete structure having several short blunt processes along the ventral and posterior surfaces, and three rather digitate, more attenuate processes anteriorly. The stem of the kidney-shaped herniated portion arises from a dorso-lateral position on the fat-body and is obviously a grossly hypertrophied process of the main body.

This picture is entirely distinct from that of the right side where the fat-body arises in the same manner as on the left, but divides into two plates of equivalent size, each with a short proximal flattened portion 5 mm. long by 10 mm. wide, and breaking down into three long processes. These processes are 15 mm. in length, taper gradually from the base to the free tip and bear each three or more short, flat, bluntly-tapering finger-like processes. The whole fat-body on this side is freely suspended in the abdomen without attachment other than at the origin.

In contrast, the dorsal portion of the left fat-body is attached by five narrow mesenteric bridges rising from the body-wall and inserted onto the fat-body posterior to the herniated lobe; and a sixth bridge passing from the anterior end of the fat-body to the apex of the lung. The latter bridge contains blood-vessels. The herniated lobe crosses in the same plane as the mesenteric bridges to the body-wall, and flattens on entering the shallow groove between the body-wall muscles and the muscle mass covering the lateral aspect of the ilium. This portion of the lobe then passes between these two groups of muscles and through a fairly well-formed aperture with a thickened, strengthened edge before expanding into the herniated mass.

This appears then to be a herniation similar to that of the oviduct previously reported. The indication is that a lobe of the fat-body has developed and followed one of the mesenteric bridges to the root of the mesentery where further growth has been along inter-muscular fascia and through into the dorsal lymph-space. It is difficult to understand the striking differences between the right and left fat-bodies. The development of an essentially undivided fat-body with the suppression of lobes and of processes cannot be simply explained in terms of the normal anatomy of the region nor can it be referred to as a consequence of the herniation.

Discussion

H. aurea is the laboratory frog in Australia and New Zealand and many

specimens must come under observation each year, but I have failed to locate any report on the occurrence of herniation elsewhere nor have my enquiries on this point resulted in any positive information. Since herniation has an anatomical and physiological basis, its occurrence in this district may have peculiar significance. The species is not native to this country, but was introduced from Australia in 1867 (Thomson, 1922), and has been in the Wellington district for at least thirty years. The fact that all three hernias so far described involve the reproductive system is not surprising, since this system undergoes major seasonal changes in size and complexity, permitting opportunity for herniation to occur. The hernias are all unilateral, and the reproductive system is normal on the opposite side. The hernias of the oviduct and of the fat-body may be considered as accidents in the course of the seasonal development of the reproductive system. Certainly, this seemed to be the case for the oviduct, but the testicular fat-body, apart from the hernia, is a grossly abnormal structure, and in this is similar to the cystic ovary.

The occurrence in *H. aurea* of three hernias in this district, an incidence of at least 0.3 per cent in contrast to the nil records elsewhere for this and other species, may be a reflection from our peculiar climatic conditions, which are extremely unsettled, liable to abrupt and violent change especially in the winter and spring when, owing to the nature of Cook Strait, a change in three degrees in the direction of a southerly wind will lead to a change from clear hot weather, to overcast skies and violent cold southerly winds. Recognizing the seasonal influence on the development of the reproductive system it is not difficult to appreciate that such sudden swings may induce abnormal development of one part or another of the reproductive system and lead to conditions such as have been described.

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Notes on the Food Habits of the Salamanders of Crater Lake, Oregon

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CRATER Lake is situated in the caldera of an extinct Pleistocene Volcano, Mount Mazama, of the high Cascade Mountains in southern Oregon. The surface of the lake is 6,177 feet above sea level; the surface area is approximately 21 square miles, and the maximum depth is slightly less than 2,000 feet. In most places at the edge of the lake sheer cliffs or steep talus slopes rise to between 500 and 2,000 feet above the surface. Much of the shoreline consists of irregular wave-washed fragments of andesite, dacite, and to a lesser extent other lava fragments varying in size from a few inches to several feet in diameter. Beneath these fragments, where there is dampness due to wave action, are found the adults of the two species of Crater Lake salamanders, *Ambystoma macrodactylum* Baird and *Triturus granulosus mazamae* Myers. The subspecies *mazamae* is, insofar as now known, endemic to Crater Lake. The adults of the two species occur in approximately equal numbers and apparently in precisely the same daytime habitat since I have found many times individuals of both species under the same rocks.

In August, 1946, I collected 56 salamanders for purposes of stomach examinations. Of these, 27 were *Ambystoma macrodactylum* and 29 were *Triturus granulosus mazamae*. The identifications were made by Dr. Edward H. Taylor, Museum of Natural History, University of Kansas, in which museum specimens have been deposited. Specimens of both species were almost invariably taken from beneath the same rocks.

Of the 27 stomachs from *Ambystoma macrodactylum*, 19 contained food material. Fourteen of these (74 per cent) contained terrestrial arthropods, almost always in fragments. These were mostly pieces of ants, beetles, and flies. Around and beneath the rocks under which the salamanders were taken I found many fragments of these terrestrial arthropods; entire individuals were rarely found. The stomachs of *Triturus granulosus mazamae* contain whole individuals of fresh-water amphipods, aquatic arthropods of more delicate nature than the above-mentioned terrestrial arthropods. These fresh-water amphipods are available alive and presumably are taken alive by *mazamae*. Because of the almost constantly fragmentary nature of the terrestrial arthropods found both in the stomachs and the environment of *macrodactylum*, and because the more delicate amphipods occur as entire individuals in the stomachs of *mazamae*, I infer that *macrodactylum* obtains terrestrial arthropods primarily as fragments by scavenging. Seven stomachs (37 per cent) of *Ambystoma macrodactylum* contained the larvae of coleopterous, dipterous, and trichopterous aquatic insects, two stomachs held unidentifiable material and one only a fragment of andesite about one centimeter in length.

Of the 29 stomachs of *Triturus granulosus mazamae* examined, there

were 27 with food material. Sixteen contained (one to 16 per stomach) the fresh-water amphipod, *Hyalella azteca* (Saussure), which is extremely abundant along the shore of Crater Lake. The identification of this amphipod was made by Dr. J. G. Mackin, Department of Zoological Sciences, the Univer-

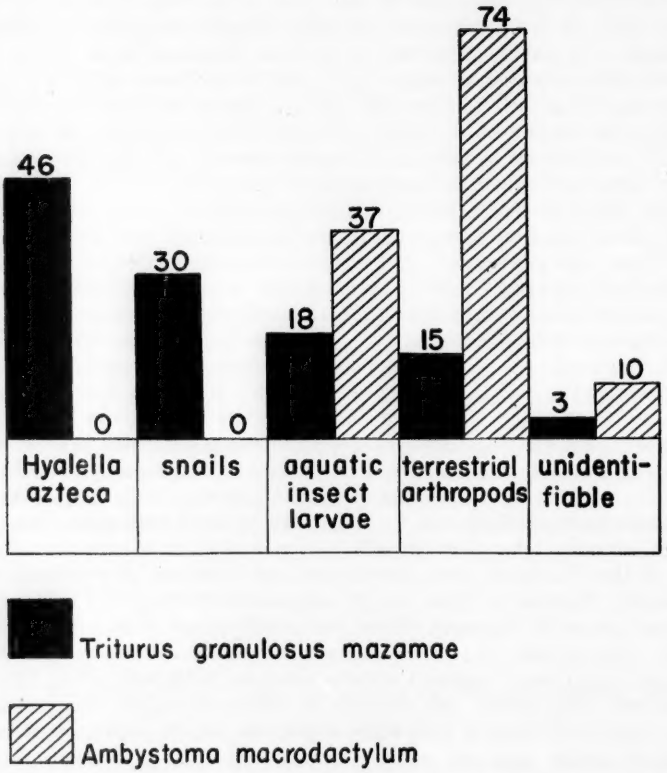

Fig. 1. The relative abundance of various items of food in the stomachs of Crater Lake salamanders. The number above each column represents the percentage of stomachs containing the item designated at the base of the column.

sity of Oklahoma. Nine of the stomachs containing *Hyalella azteca* contained no other items. Eight stomachs (30 per cent) contained snails (one to 15 per stomach). The species of snails involved were *Parapholyx effusa effusa* (Lea), *Lymnaea mazamae* J. L. and Ruth I. Bailey, and *Menetus* sp. The identifications were made by Dr. H. A. Pilsbry, Philadelphia Academy of Sciences. *Parapholyx effusa effusa* and *Lymnaea mazamae* (endemic to Crater Lake) were the most numerous. The *Menetus* sp. was encountered

only once. Of the eight stomachs containing snails, four had only snails; in the other four, there were also specimens of *Hyalella azteca*. Five stomachs (18 per cent) contained aquatic larvae of dipterous, coleopterous, and trichopterous insects. Four (15 per cent) contained terrestrial arthropods or fractions thereof, and one of these also a fresh-water amphipod. One stomach held only unidentifiable material.

The data on the stomach contents of the two species of Crater Lake salamanders are compared in the accompanying graph (Fig. 1). Apparently *Ambystoma macrodactylum* is primarily a scavenger but takes a few live aquatic insect larvae, whereas *Triturus granulosus mazamae* is primarily predacious, its principal sources of food being snails, amphipods, and insect larvae. *Triturus granulosus mazamae* also obtains a few dead arthropods. Since all of the food items mentioned in the above paragraphs occur reasonably abundantly beneath and around the rocks under which both species of salamanders are found, the two species probably have the same opportunities to obtain food. The difference in stomach contents, therefore, represents a true difference in feeding habits, at least for the period represented by the study. The rather abundant fresh-water turbellarians were never found in the stomachs of either species. Either they were not taken as food or they passed from the stomach in the interval between night, when they would have been eaten, and the middle of the morning, when the salamanders were collected. Adult aquatic beetles, also numerous, were never found in the stomachs of either species of salamander. Plants, other than filamentous algae, were not available to the salamanders.

Lack (1946), in a recent review of competition among strigiform and falconiform birds, points out that no two congeneric species that feed in the same habitat compete for food and further that the same holds for species even though they be of different genera. It appears that this thesis can be applied to the Crater Lake salamanders.

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The Embryonic Development of the Pituitary Body in the Chameleon

By HAJA HORN

IN comparison with the immense literature on the pituitary body of mammals, birds and even of some other groups of the lower vertebrates, the number of papers dealing with that gland in reptiles is very small. The pituitary body of the chameleon has not, as yet, been treated in any special research, a fact the more surprising, as chameleons are known for their peculiar characteristics and uncertain position in the systematics of the Squamata.

The object of the present investigation [1] is the description of the embryonic development of the pituitary body in the common chameleon, in *Chamaeleo chamaeleon chamaeleon* Linnaeus. Its anatomy and histology have been taken into consideration only insofar as they are necessary for the understanding of the development.

A series of 13 embryonic stages and a neonatus served as material, all obtained in the vicinity of Jerusalem, Palestine. The age of the youngest embryo, opening the series, is unknown, but the neonatus, fixed 3 days after hatching, is known to be 103 days older. It follows that the present series of embryos covers 100 days of the development, whereas the complete embryonic period in *Chamaeleo* is known to last 125 to 133 days (Fisher, 1882). After a diapause of approximately 7 months, from October, when the eggs are laid, development may begin in the end of April or later, until about the middle of May. The first embryo of the present series dates 28.V.

Fixation of the younger embryos was made at intervals of from 5 to 10 days and that of the older ones of from 14 to 25 days. Bouin, Müller and Zenker fixatives were used. The embedding of the younger embryos was made in paraffin, that of the older, in which bone has developed, in Kolmer's celloidin-paraffin or Péterfi's methyl-benzoat-celloidin-paraffin. The embryos were cut in transverse and sagittal directions in slices 10 μ thick. The staining methods used in the younger embryos were Dominici and Delafield haematoxylin and eosin. In the older embryos Petersen-azan proved to be very suitable, as it stains the different parts of the pituitary body in different colours.

At the beginning of the development of the hypophysis in reptiles, Rathke's pocket arises by invagination from the oral epithelium. It touches the forebrain with its roof and a part of its anterior wall. Soon, at both sides of this central process, the oral epithelium pushes out two smaller processes, which grow dorsad.

In the youngest embryo of the series Rathke's pocket already appears, accompanied by the lateral processes. It is thin-walled and elongated, as seen

1 This work was carried out in the Department of Zoology, The Hebrew University, under the supervision of Dr. Georg Haas, to whom I am greatly obliged for his kind assistance and interest. I also wish to express my sincerest thanks to Dr. H. Steinitz for his constant advice and instructions.

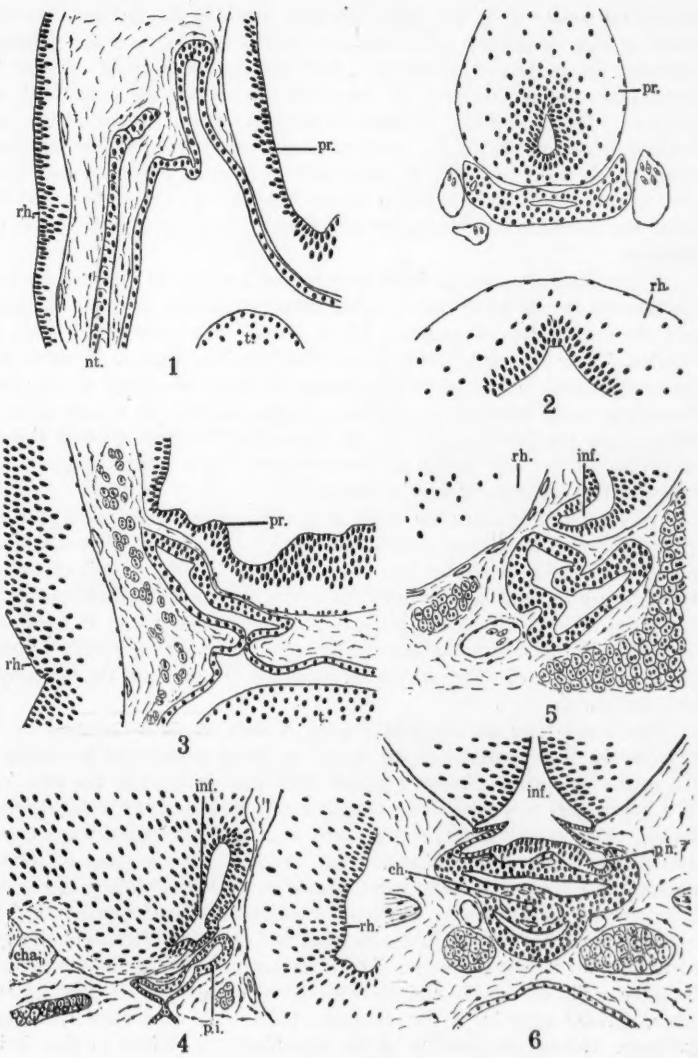


Plate I

1. Stage I, sagittal section, Delafield haematoxylin and eosin stain, 120 ×. 2. Stage III, transverse section, Dominici stain, 120 ×. 3. Stage V, sagittal section, Delafield haematoxylin and eosin stain, 120 ×. 4. Stage VI, sagittal section, Delafield haematoxylin and eosin stain, 80 ×. 5. Stage VII, sagittal section, Delafield haematoxylin and eosin stain, 120 ×. 6. Stage VII, transverse section. Dominici stain, 120 ×.

ch., channel; cha, chiasma; inf., infundibulum; nt., notochord; p.a., pars anterior; p.i., pars intermedia; p.n., pars nervosa; pr., prosecencephalon; rh., rhombencephalon; t., tongue.

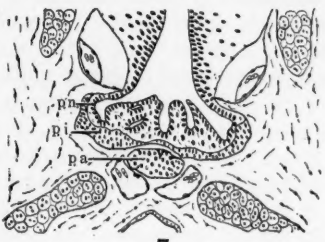
in sagittal section (Fig. 1). Only the roof, touching the forebrain, is composed of high cylindrical cells. Between Rathke's pocket and the rhombencephalon the notochord passes as a thin rod, its end turned towards the hypophysis, but not touching it. In transverse section the hypophysis appears as a flattened strand of tissue, closely applied to the base of the forebrain and perforated by the cavities of the central and lateral processes (Fig. 2). It is accompanied on either side by a blood vessel. A wide aperture leads from the central cavity of the hypophysis to the mouth. At this stage the premandibular somites are already differentiated into the eye muscles.

A few days later several folds form behind the central process, the most conspicuous in size being the so called lobus proximalis. Between the latter and the central process passes a blood vessel. The more distal lobes are smaller. These folds are present in all Craniota investigated. It seems that their appearance has a certain significance in the development of the gland. According to its topographic position, the pars anterior or a part of it develops from the proximal fold. It is, however, difficult to confirm this assumption, as the fold is distinct during a very short period and soon enlarges and unites with the central process.

At the following stage the walls of the hypophysis have undergone certain changes. The columnar cells constitute the whole of the walls of the hypophysis, the demarcation line between them and the mouth epithelium being clearly brought out. In addition a new fold, touching the base of the forebrain, arises in front of Rathke's pocket. The new fold is small and flattened. As this new fold arises, the oral epithelium behind Rathke's pocket sinks deeper, thus effecting the partial closure of the outlet of the hypophysis into the mouth.

Nine days later an essential change is seen to have occurred in the hypophysis. The aperture to the mouth is closed completely by fusion of the epithelium behind Rathke's pocket with that in front of the new fold. The hypophysis now consists of a stalk and a main body: the hypophysial vesicle. The stalk is short, straight and hollow. The vesicle, when closed, includes the small space of the new fold and the primary space of Ratke's pocket. This pocket is much longer than the new fold, therefore the vesicle is flat, broad and semilunar in shape. Folds appear in the wall turned towards the brain; the wall sinks somewhat and elements of connective tissue enter between it and the brain. The plica ventralis of the brain sharpens; thus the walls of the di- and rhombencephalon come to lie near to each other, divided only by a narrow space filled with connective tissue and cartilage. Hence, the position of the hypophysis is shifted so that it becomes situated almost ventrally of the brain, only its caudal edge entering between the di- and rhombencephalon. The notochord has shortened, its cranial end no longer extends beyond the posterior wall of the rhombencephalon (Fig. 3).

At this stage the morphological and histological differentiation of the hypophysis sets in. The part adjoining the infundibulum elongates into a vesicle, which in future will form the pars intermedia (Fig. 4). The hypophy-



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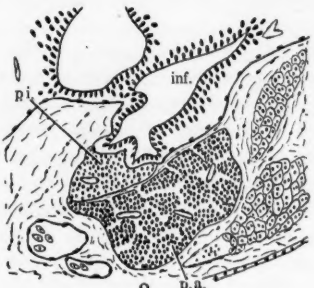

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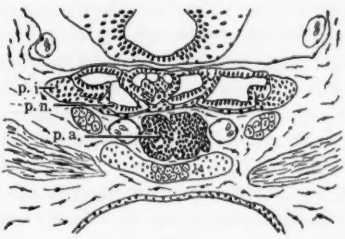

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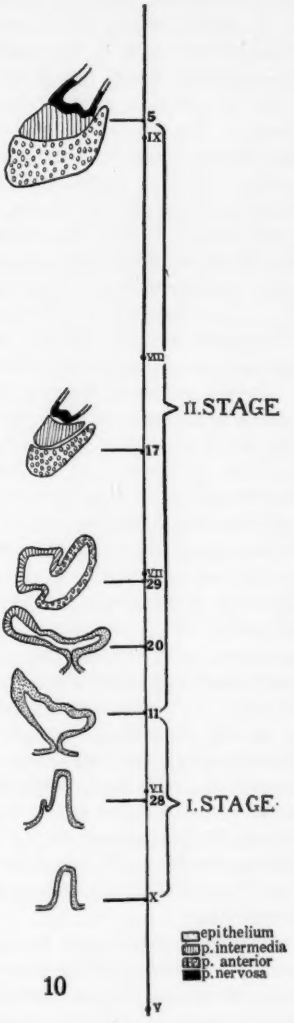

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PLATE II

7. Stage x, transverse section, Dominici stain, 80 ×. 8. Neonatus, sagittal section, Petersen's azan stain, 120 ×. 9. Neonatus, transverse section, Petersen's azan stain, 80 ×. 10. Scheme of the embryonic development of the pituitary body of *Chameleo*.

inf., infundibulum; p.a., pars anterior; p.i., pars intermedia; p.n., pars nervosa.

sis appears from now on as a pseudostratified columnar epithelium, owing to the numerous nuclei placed at various levels.

A sagittal section of the next stage embryo shows the di- and rhombencephalon very close to one another (Fig. 5). Their adjoining walls are separated only by a very thin layer of pia mater, pervaded by blood capillaries. Thus the position of the hypophysis is definitely ventral to the brain and dorsal to the mouth. All its parts have changed in shape. The p. anterior has elongated and bent in its cranial part so that it now touches the brain in front of the infundibulum. From the p. anterior a conic vesicle has developed, connected with it by means of a short channel. This new vesicle is the pars intermedia. In sections to the right of the center of the hypophysis, the hypophysial stalk appears in fragments only, undergoing degeneration. Transverse sections show a wide p. intermedia with a big cavity (Fig. 6). The connecting channel is round, has thick walls and a narrow lumen. Underneath is the p. anterior with a still wide cavity, and thickened walls. Lateral of it pass the two internal carotids.

In the following embryos the most conspicuous changes are those occurring in the infundibulum, which lead to the formation of the pars nervosa. The infundibulum is seen to have pushed out numerous diverticula. The walls of the latter have thickened and consist now of fibrillar structures, while the lumen is lined by a dense layer of ependym cells. These diverticula constitute the p. nervosa. The line separating the infundibulum from the p. nervosa on the dorsal side is clear, whereas the tuber cinereum has grown out on the ventral side as a thick swelling of the infundibular wall. Regarding the other parts, in the p. intermedia the cavity is obliterated, being filled with cells. The p. anterior appears as a mass of folded tissue, the folds more numerous in the caudal than in the cranial part. In the center they are compressed into a continuous mass filling up the primary cavity. There are only a few slits, some of them containing blood vessels (Fig. 7).

In the neonatus the p. anterior consists of lobes and groups of cells, between which enter numerous blood vessels (Fig. 8). The p. intermedia appears as a thin layer above the p. anterior, penetrates between the lobes of the p. nervosa and has at its ends triangular thickenings (Fig. 9). Here indeed, its glandular character is most conspicuous. In the walls of the p. nervosa the dense fibrils and the neuroglia cells among them, are easily made out. The blood supply is most abundant where the p. nervosa adjoins the p. intermedia.

In the neonatus, as in the adult, the pituitary body is a continuation of the infundibulum, turning from the brain ventro-caudal and finally entering the sella turcica. On its ventral and caudal sides there is the basisphenoid, at the cranial end there is a protecting cartilage. Fibrous membranes derived from the pia and dura mater enclose the whole gland. All these structures together form a hard capsule around the pituitary body. The two internal carotids, connected by a horizontal anastomose behind the gland, pass within this capsule. The pituitary body appears as consisting of two well defined parts, i.e., p. intermedia situated above p. anterior. Only the upper surface

of the p. nervosa is visible on the dorsal side of the gland, while the rest of it is embedded in the p. intermedia.

Discussion

The development of the pituitary body in *Chamaeleo* may be briefly compared and contrasted with the embryology of this organ in other reptiles.

The hypophysial vesicle after its closure differs greatly in shape and topography from those of *Lacerta agilis* and *Natrix natrix,* but resembles that of *Chrysemys b. marginata.* It is flattened, its two arms are of unequal lengths and the stalk originates in the cranio-ventral part, whereas in the lizards the vesicle is bent in U-shape, its stalk originating in the middle between the two arms. According to de Beer (1926), this is the characteristic form of the vesicle in the lizards, while according to Baumgartner (1916), this form appears also in the snakes, though not so distinctly marked. If we accept this form of the hypophysial vesicle as characteristic of the Squamata, the conclusion will be that *Chamaeleo* differs in this regard from the lizards and from the snakes alike, and resembles to a certain extent the turtles.

The stalk, which is short and straight and soon degenerates, is similar to that of the lizards and turtles and contrasts with the long curved stalk of the snakes and of *Alligator.*

Among the structures surrounding the unfolding hypophysis, the notochord is noteworthy because of the differences in its fate in the various groups of reptiles. In the lizards the notochord is closely applied to Rathke's pocket, touching it even after the closure of the vesicle. In the snakes the end of the notochord degenerates soon and it does not touch the hypophysis at all. In *Chamaeleo* the notochord does not touch Rathke's pocket even in the youngest embryo of the series and its end appears to be degenerating. When the vesicle closes, the end of the notochord barely reaches the rhombencephalon.

The fate of the lobi laterales in *Chamaeleo* resembles that of the same structures in the snakes. The lateral lobes grow out to the sides of Rathke's pocket, but after a short period of existence they shorten and their cavities disappear. The lateral lobes give rise to the pars tuberalis, wherever this latter is formed. The p. tuberalis of mammals, birds and amphibians is well developed, while among the reptiles, if existing at all (*Sphenodon, Chrysemys, Alligator*), it appears somewhat degenerate. It is altogether absent in snakes. According to Baumgartner (1916) and de Beer (1926), the fate of the lateral lobes and the p. tuberalis in a certain species-group of the genus *Lacerta* is a very interesting problem. In *Chamaeleo* an examination of series of adults showed a complete lack of a p. tuberalis, though the lateral lobes appear in the young embryo.

The anatomy of the pituitary body of *Chamaeleo* is well in line with de Beer's (1926) scheme of the evolution of this organ. In the lizards the hypophysial cavity persists in the p. intermedia, the position of the p. anterior being ventral, while in the snakes the cavity disappears and the p. anterior takes up a caudal position. Thus, from the anatomical point of

view the pituitary body of *Chamaeleo* has its place just between those of the two groups of Squamata, as the hypophysial cavity disappears, while the position of the p. anterior is still ventro-caudal to the other parts of the gland.

SUMMARY

Two stages may be distinguished in the development of the pituitary body in *Chamaeleo:*

1. The unfolding of the hypophysis.
2. The morphological and histological differentiation of the gland.

The first stage comprises the unfolding of the hypophysis from a small process in the epithelium of the mouth roof until the closure of the hypophysial vesicle and the formation of the stalk and main body.

During the second stage the p. intermedia emerges from the p. anterior in the form of a cone, communicating with the latter by means of a short channel. The lateral lobes degenerate. The p. anterior enlarges, its folds forming the characteristic lobes of a gland. The infundibulum elongates, giving off many diverticula towards the p. intermedia and forming the p. nervosa. The p. intermedia penetrates between the p. nervosa and p. anterior as a thin layer. The broad base of the p. nervosa and thus the wide horizontal extension of the p. intermedia are noteworthy.

In the neonatus all parts of the gland are fully developed from a morphological point of view. However, the histological differentiation of the gland is not yet complete.

The closed hypophysial vesicle of older *Chamaeleo* embryos is almost flat, the stalk originating in its cranial part. This shape of the vesicle is a striking feature, as that of lizards is U-shaped, with the stalk originating in the middle.

In the fully developed pituitary body of the adult the p. tuberalis is absent and the cavity obliterated.

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Straub Phenomenon Produced by Venom of *Micrurus fulvius*

By David I. Macht

THE Straub phenomenon is a well known reaction in pharmacology, first described by Otto Hermann, a pupil of the famous pharmacologist, Walter Straub. It was first published under the title of "Eine Biologische Nachweismethode des Morphins" (1912, Biochemische Zeitschrift, 39: 216). The author describes a characteristic stiffening and erection of the tail in mice after injection of morphine. This upbending in extreme cases assumes an S shape, but such an S shape does not usually occur and any degree of stiffness and bending back of the tail is considered a positive Straub reaction. This phenomenon is exhibited also by white rats but because of the heavy tail in those animals the bending usually consists of a so-called "poker" tail. The Straub phenomenon was originally thought to be diagnostic for morphine but was found even by Straub and his pupils to be produced by other morphine derivatives and also by some of the other alkaloids, particularly by nicotine. Later work by Professor Van Leersum, Dutch professor in Leiden, showed that the Straub phenomenon is due to a spasm of the sphincter ani produced by the action of drugs or poisons either directly on the muscle of the sphincter or indirectly through an action on the spinal column (1918, Nederlandsch Tijdschrift voor Geneeskunde, 62: 1374).

This interesting phenomenon, even in the original communication, was described as not possessing any quantitative exactness and, therefore, could not be relied upon from a forensic point of view as sufficient evidence for the presence of morphine in the body tissues or fluids, but it does serve as a lead to be followed and corroborated by exact chemical work. Macht showed that the phenomenon produced by morphine and its derivatives is really due to one part of the morphine molecule (1920, Proc. Soc. Exp. Biology and Medicine, 17: 100), namely the piperidine nucleus, so that the chemical piperidine alone can also produce it. As a matter of fact, this spasm of the sphincter ani and consequent raising of the tail is obtained in mice even after intraperitoneal injections of various irritating solutions and of distilled water alone which is also irritating to the peritoneum.

More recently the mouse tail test has been advocated as a means of detecting doping in race horses, because when morphine is administered to a horse it is excreted in the saliva. While this is true, such a test is not at all conclusive because all kinds of drugs or chemicals found in the saliva may give a mouse tail reaction. Thus, for instance, the present writer found that potassium sulphocyanate, a normal constituent of saliva, when injected in mice and white rats may produce a Straub phenomenon. Again a chemical known as D.O.T.G. or di-ortho-tolyl guanidine, used as a vulcanizer in the manufacture of rubber washers, etc., can also produce not only a positive Straub mouse-tail reaction, but give some of the chemical color reactions of morphine. Thus, saliva kept in a jar with such a rubber washer may give a misleading Straub phenomenon.

In the present paper the writer wishes to call attention to a snake venom that produces a positive Straub reaction, as striking and even more so than that of morphine. It is the venom of the coral snake, *Micrurus fulvius*. As far back as January, 1943, the author was making experiments on the absorption of all kinds of snake venoms by stomach as compared with their absorption and poisonous effects by parenteral injection. On examining the rare and very powerful poison of the coral snake, notes were made in the laboratory records of a very striking Straub phenomenon following injections of minute quantities of this venom. The lethal dose of the venom in the author's possession was 0.02 mgs. per mouse weighing 20 gms. Even smaller doses, not followed by a fatal outcome, produce a marked stiffening and bending back of the tail. The striking bending back of the tail thus gives another illustration of the Straub phenomenon produced by drugs which have no relation whatever chemically to the morphine group of alkaloids.

Curiously enough no other snake venom, so far examined by the author, gives a similar Straub mouse-tail reaction. Incidentally it may be added that small quantities of coral snake venom introduced into the stomach of a mouse by a suitable "stomach tube" is absorbed and will produce death, although the lethal dose is 10 to 20 times that required to kill by subcutaneous or intraperitoneal injection. An extensive research dealing with the comparative toxicity of all kinds of snake venoms given by injection and by stomach is in preparation.

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Herpetological Notes

BOX TURTLE EATING A HORNED TOAD.—According to Pope (1939, Turtles of the United States and Canada: 143), the ornate box turtle has been reported as attacking and eating a six-lined race-runner, in captivity. Other than this he gives no instance of any box turtle preying upon a vertebrate animal.

An adult *Terrapene ornata* (Agassiz), which had been in the same cage for four days with an adult *Phrynosoma cornutum* (Harlan), was seen holding the lizard down with one foot and eating the hind quarters. The lizard, alive when first noticed, made no attempt to escape. The turtle abandoned its prey after consuming one hind leg, the sacral region, and about one fourth of the trunk. It had eaten, without discrimination, the spiny skin, bones, and part of the viscera.—THEODORE H. EATON, JR., *Biology Department, Southwestern College, Winfield, Kansas.*

A COLLECTION OF AMPHIBIANS FROM GEORGIA.—The following records of amphibians from various counties in Georgia are of specimens in my private collection, collected by myself except as otherwise stated.

Amphiuma means means (Garden).—A specimen from 4 miles west of Augusta, Richmond County, January 1, 1946, collected by W. T. Neill and I. G. Rucker, Jr., is the smallest transformed individual in my collection, being only 60.5 mm. in total length. It agrees essentially with adults from this area, except in the shape and proportionate length of the tail. This organ, comprising 24.8 per cent of the total length, is flattened and rounded at tip. It is keeled above on the distal three-fourths, below on the distal half. The specimen was found in muck on the bottom of a small stream.

Ambystoma talpoideum (Holbrook).—A specimen from 4 miles west of Augusta, Richmond County, December 29, 1945, is an adult 90 mm. in length, taken with a dip-net from the bottom of a small pond, along with several *Triturus viridescens viridescens* (Rafinesque). Previous Georgia records have been from the lower Atlantic Coastal Plain.

Desmognathus quadramaculatus quadramaculatus (Holbrook).—Specimens from Tiger, Rabun County, June 14, 1938, are intermediate between the typical form and *D. q. amphileucus* Bishop. The characteristic color pattern of the latter is distinct in three specimens under 100 mm. in total length, becoming less so in those exceeding this size. In the smallest, 91 mm. total length, the anterior half of the head, the sides of the head as far back as the postocular light line, the gular region, the limbs, and the distal two-thirds of the tail are whitish, lightly mottled with tan or gray. There is a whitish band from axilla to groin, and vertical white dashes on the costal grooves. The palms, soles, and region about the vent are also whitish. The dorsum, venter, and proximal third of the tail were sepia in life, are slaty black in preservative. The largest individual, total length 143 mm., is mostly uniform black above and below, with lighter mottlings about the legs, snout, and side of head. The margin of the lower jaw is white with gray mottlings. The palms and soles are whitish, and there are white fleckings about the vent. The tip of the tail is brown. In all of this series the costal grooves number 14, with 2 or 3 intercostal folds between the appressed limbs; and the horizontal diameter of the eye is contained at least 1½ times in the length of the snout. The specimens were found beneath rocks and logs in a small stream.

Gyrinophilus danielsi dunni Mittleman and Jopson.—Specimens from Stone Mountain, DeKalb County, December 21, 1940, collected by John W. Crenshaw, Jr., and H. C. Gardner, and from Atlanta, DeKalb County, December 22, 1940. These were previously reported (Copeia, 1941: 177) as *G. porphyriticus danielsi* (Blatchley). The Atlanta specimen is a male measuring 141 mm. in total length. The ground color is dark orange-red above, becoming orange laterally and deep yellow ventrally. There are a few brownish spots along the mid-dorsal anterior extensions of the costal grooves, forming a poorly defined pattern of chevrons. The venter is immaculate, as is the gular region. The lower jaw is mottled with dark brown. The light line along the canthus rostralis is very distinct, heavily bordered with dark brown below and margined with brownish spots above. The iris of the eye was a bright green in life. The costal grooves number 18, with 8 intercostal folds between the appressed limbs. The specimen was found beneath a rock in a small, swift stream. One of the Stone Mountain specimens is a larva 87 mm. in length. In life it was purplish above, lavender below. In preservative it is purplish-gray with a white venter. There are light-colored sensory organs about the head, along the sides, and on the lateral surfaces of the base of the tail. The gular region is streaked anteriorly with purplish-brown. The tail is very stout, abruptly tapering, and keeled above and below.

Bufo terrestris americanus (Holbrook).—A specimen from Whitehall, Clarke County, September 27, 1939, affords the southernmost record of this form that has come to my attention. The specimen is 55 mm. in snout-to-vent length. There are numerous large warts on the dorsum and dorsal surfaces of the legs, many with horny excrescences. The snout is short and truncate, not extending beyond the tip of the lower jaw. The parotoid glands are oval. The cranial crests are low and divergent posteriorly. The preparotoid ridge is short but distinct, contained about 4 times in the postorbital ridge. The latter ridge is well developed, and as conspicuous as the cranial crest. In life, the dorsum was orange-red, with small brownish spots each inclosing one wart. The venter was dirty white flecked with gray on the pectoral region.

Bufo woodhousii fowleri Hinkley.—In specimens of Fowler's toad from the Whitehall area, the warts are small, either without horny excrescences or very minutely spine-tipped. The snout is somewhat rounded in profile, extending beyond the tip of the lower jaw. The parotoid glands are elongate oval. The cranial crests are parallel or slightly divergent posteriorly. A preparotoid ridge is lacking, the parotoid glands being in contact with the postorbital ridge. The latter ridge is low, narrow, and much less conspicuous than the cranial crest. The color is greenish or gray with dark spots that often inclose five or six warts. There is usually a white dorsal stripe. The venter is immaculate. The breeding voices of both *americanus* and *fowleri* have been heard in Clarke County. Of the two forms, *B. woodhousii fowleri* is by far the commoner in that locality.

Pseudacris feriarum (Baird).—A large series of specimens from Rae's Creek on the northwestern outskirts of Augusta, Richmond County, December 29, 1940, was collected by W. T. Neill and I. G. Rucker, Jr. These specimens were part of an enormous colony that was breeding in flooded bottomlands along a small creek. Of 150 examples collected, 136 were males, 14 females. A considerable degree of individual and sexual variation was noted.

The males ranged in length from 22.25 to 28.75 mm., averaging 25.84 mm. In these, a dorsal pattern of more-or-less unbroken stripes occurred in 85, a pattern of spots in longitudinal arrangement in 23. The dorsum was irregularly spotted in 18, immaculate in 1, and uniformly black in 9. The chest was distinctly spotted with brown in 18, lightly flecked with brown in 40, immaculate in the remainder. A distinct triangle between the eyes, its apex directed backwards, was present in 20; and in 50 others there was an indistinct triangle, somewhat diffused anteriorly. In 40 there was an irregular interocular spot, while 17 were unmarked about the head. In the 9 very dark individuals, no markings could be discerned. There was considerable variation in the granulosity of the dorsum. The ground color of the dorsum was occasionally buffy, but usually some shade of greenish-gray. The venter was dirty white, the vocal sac slaty. One specimen was covered ventrally and laterally with large whitish nodules, evidently a pathologic condition.

The females were larger, ranging from 27 to 31.75 mm., averaging 28.84 mm. Of these, 10 were striped, 1 was marked with rows of spots, and 3 were irregularly spotted. The chest was distinctly spotted in 4, lightly flecked in 6, immaculate in 4. A definite interocular triangle was present in 2, present but diffused anteriorly in 5. An irregular marking was present in the remaining 7. The dorsum was smoother than in most males. The ground color of the dorsum ranged from buff or tan to a rich red-brown. The venter was yellowish, the throat white. Several of the females were reminiscent of *P. brimleyi* Brandt and Walker, from which they differed in the presence of transverse tibial markings and a poorly defined lateral stripe.

Hyla ocularis Bosc and Daudin.—Two specimens from DeBruce, Richmond County, April 27, 1940, form the first record from the Fall Line tier of counties. Specimens were found hopping about on reeds and grass blades at the edge of a marsh. None was heard calling, although a male, 14.5 mm. in length, had the vocal sac distended. The species is referred to *Hyla* following Harper (1939, Amer. Midl. Nat., 22: 134).

Rana heckscheri Wright.—One specimen from Magnolia Springs, near Millen, Jenkins County, April 27, 1940; and a series of larvae from a small pond adjacent to the Ogeechee River, near Cushingville, Jenkins County, April 27, 1940. The Magnolia Springs specimen is an adult 94 mm. in snout-to-vent length. It was sitting in shallow water at the edge of a lake, in bright sunlight. The larvae from Cushingville range in length from 76.5 to 84 mm., with the hind legs developed to a length of 10 to 12 mm. The strikingly marked tadpoles were common in small ponds along the densely wooded banks of the Ogeechee River. The species was also taken along Little Spirit Creek, Richmond County, a little below the Fall Line.

Rana palustris LeConte.—A specimen from Oconee River near Whitehall, Clarke County, September 27, 1939, is the southernmost Georgia locality of which I have record. —Wilfred T. Neill, *Augusta, Georgia.*

HABITAT OF *DESMOGNATHUS QUADRAMACULATUS AMPHILEUCUS*.—Bishop (1943, Handbook of Salamanders: 214) reports he has no knowledge of the circumstances under which the type specimens of *Desmognathus quadramaculatus amphileucus* Bishop were found, and since this salamander is known only from its type locality, I have investigated its habitat.

There were no steep slopes in Demorest, Habersham County, Georgia, to support fast streams where *D. q. quadramaculatus* might occur, but inquiry located the only small fast-flowing stream known locally, a little brook cascading over an abrupt outcropping down a steep slope into the Chatahoochee River, 3 miles west of Demorest in the direction of Cleveland, Georgia.

A recent rain had saturated the stream with silt, and only 20 feet above the junction with the river I saw my first *D. q. amphileucus* with its head raised over a stick and leaf dam in the tiny stream. This specimen and 3 others were collected from this stream, the last 3 being taken in the steep, rocky area of cascades and pools on the east side of the dirt road. All specimens were extremely active, and difficult to secure. The salamanders were first seen out of water, usually beneath an overhanging rock behind a tiny falls. They needed little provocation to cause them to dash for the nearest pool, and were fast swimmers. After entering the water they would dive beneath a flat rock (usually too large for me to move) and remain there from 10 to 20 minutes. One specimen that escaped me three times always returned to exactly the same terrestrial basking site. *Eurycea bislineata cirrigera* and *Natrix septemvittata* were collected from this stream also. —JOHN THORNTON WOOD, *Antioch College, Yellow Springs, Ohio.*

NOTES ON NORTH CAROLINA SALAMANDERS.—Miscellaneous notes on two species of *Plethodon* and one of *Eurycea* are assembled under this heading.

SIZE OF ADULT *Plethedon glutinosus shermani* STEJNEGER.—Bishop (1943: 253–4), in reporting on the size of adult *Plethedon glutinosus shermani*, stated that the males he measured averaged considerably smaller than the females. The number of males he examined is not mentioned, but an average total length of five adult females is cited as 130.2 mm. (range, 115-147).

On May 30, 1946, R. L. Kathe, J. D. Murray, and the author collected 18 males and 20 females of this species on Wayah Bald, Nantahala National Forest, Macon County, North Carolina, at 4,500 elevation. Since 9 males and 3 females had regenerated tails, they were not averaged in the following measurements (in mm.).

	Sex	No. Spec.	Extremes	Average
Total length	♂	9	79.5 — 133.5	97.1
	♀	17	62.5 — 129.3	92.5
Tail length	♂	9	40.0 — 70.5	47.5
	♀	17	29.0 — 62.5	44.5
Tail/total	♂	9	? — ?	48.9
	♀	17	? — ?	48.0

Bishop's observations may have been based on an atypical series. To keep my series a random one, every specimen encountered was collected; the area from which they came was approximately 100 x 50 yards, making this series an unselected population from a restricted area.

Although Bishop's largest specimen, a female, was 153 mm. in total length and considerably in excess of the total length of my largest specimen, I believe my data clearly establish that in this species the two sexes average almost the same size, with the males slightly larger.

ALTITUDINAL RANGE OF *Plethodon yonahlossee* DUNN.—Dunn (1926) collected *Plethodon yonahlossee* at 4,200 feet elevation, and Bishop (1943) mentions taking it at 3,200 and 5,000 feet. Bailey (1937) found the species associated with *Plethodon cinereus*, *Plethodon metcalfi*, and *Plethodon glutinosus*, though rarer and more altitudinally restricted than any of these.

Grobman(1944) clearly shows that the wide altitudinal range attributed to *P. metcalfi* by Bailey (1937) is a complex of the ranges of *P. metcalfi* and *P. clemsonae*,

and describes the range of the former as between 3,000 and 5,800 feet. *Plethodon cinereus* is considered a low-altitude form in the Great Smokies by King (1937), although *Plethodon glutinosus* exhibits an extraordinary altitudinal range of from 1,000 to 5,000 feet.

J. D. Murray collected *Plethodon yonahlossee* at 2,700 feet at the southern edge of Seven Mile Ridge on the farm of Erling Toness, Celo Community, Yancey County, North Carolina. It thus appears that *P. yonahlossee* has less altitudinal range than *P. glutinosus* in accord with Bailey's observations, but contrary to his findings it has a greater altitudinal range than either the high altitude *P. metcalfi* or the low altitude *P. cinereus*.

Finding *P. yonahlossee* in the wooded area of the valley between the mountains bordering Celo may indicate that this species can inhabit the valleys as well as the mountain slopes, and thus within its known geographic range it may have a more extensive inhabitable range than had been suspected.

Eurycea longicauda guttolineata IN GREAT SMOKY MOUNTAINS AREA.—Dunn (1926) reported collecting *Eurycea longicauda guttolineata* in the vicinity of Mount Sterling, North Carolina, but King (1937) was unable to verify its presence there, although special search was made for this species, and I have also failed to find it. King supposed that changed habitat due to extensive logging and burning of the area may have greatly reduced the species in that area.

On March 30, 1946, I collected *Eurycea longicauda guttolineata* by an open roadside seepage spring 1 mile south of Cherokee, North Carolina, on the road to Bryson City, at the base of Mt. Noble, Great Smokies, and within ½ mile of the National Park boundary. In the same habitat I collected *Haldea v. valeriae, Plethodon g. glutinosus,* and *Desmognathus ochrophaeus carolinensis.* On April 3, 1946, J. D. Murray collected an additional specimen of *E. l. guttolineata* in the same area, and *Natrix s. sipedon* in the nearby Tuckasegee River.

This is the only locality where *E. l. guttolineata* has been collected in the Great Smoky Mountains National Park area.—JOHN THORNTON WOOD, *Antioch College, Yellow Springs, Ohio.*

VARIANT SPECIMENS OF RING-NECKED SNAKES IN MARYLAND.—During a recent survey of Maryland ring-necked snakes, two specimens of *Diadophis punctatus edwardsii* (Merrem) have come to hand from Charles County that show an interesting deviation, with respect to head markings and scutellation, from the normal pattern noted in a series of about 40 specimens from all over the state.

Typically, the dorsum of the head is black with a fine yellow mottling, concentrated mainly about the snout and extending back with diminishing intensity no farther than the eyes; a yellow collar, one to two scales wide, encircles the neck and is bordered behind by a jet black area of about the same width. Normally, there are 2 pre- and 2 post-ocular scales.

The two variants under discussion are both males, respectively 314 and 270 mm. in total length; they were collected 1 mile east of Chapel Point, Charles County, Maryland, by the Rev. William H. McClellan, S.J. of Woodstock College, who very kindly donated them to my private collection. Their yellow head pigmentation is markedly more intense and extends over a greater area than in normal specimens, covering the head almost to the posterior ends of the parietal plates and giving to the whole a rusty appearance. The collar, in both, is bordered with black *anteriorly* as well as posteriorly. Both snakes have anomalous ocular scales. One has 3 preoculars on each side, 2 postoculars on the right and 3 on the left side. The second has normal postoculars and the usual 2 preoculars, but the lower ones are so reduced in size that they can be discerned only with the aid of a glass. The lower preoculars on the first specimen are also abnormally small. That these snakes are of the same brood is unlikely due to the considerable difference in their total lengths. It would be interesting to see additional specimens from this locality.—M. F. GROVES, *1821 Covington Street, Baltimore 30, Maryland.*

A NOTE ON THE FOOD OF *HETERODON SIMUS*.—At noon on May 2, 1947, I noticed a small *Heterodon* about 10 inches in length that had started to burrow in the hard packed sand under the oak trees in my front yard in Gainesville. Thinking it was only trying to hide, I picked the snake up just long enough to identify it as *simus*, then put it back down and went into the house. When I came out a few minutes later the snake had resumed burrowing in the same place. After working nearly straight down into the ground until about half buried, it stopped digging and started to back out of the hole. When all of its body except the head was uncovered I moved it with a small stick and saw that it had captured a half-grown *Scaphiopus h. holbrookii*. The snake then proceeded to swallow the spadefoot, after which it crawled off through the bushes. The whole process occupied some twenty minutes.

The hole from which the *simus* dug the spadefoot was found to be 115 mm. in depth.

That *H. contortrix* lives in sandy areas and feeds upon *Bufo* is well known. The facts that *H. simus* lives in dry woods, as does *Scaphiopus*, and that it has such a well developed "shovel" may indicate that the feeding behaviour noted above is not an unusual one for the species. Carr (1940, Contribution to the Herpetology of Florida: 80) mentions that the fossorial tendencies of this snake are inconsistent with a diet of *Bufo*. —COLEMAN J. GOIN, *University of Florida, Gainesville, Florida.*

COPULATION OF THE FOX SNAKE.—On the second of June, 1940, in a roadside park near Hermansville, Michigan, I noticed a pair of fox snakes, *Elaphe vulpina vulpina* (Baird and Girard), in a small hollow in a woods consisting mostly of elms, maples and a few pines, and with a soft blanket of dead leaves on the ground. Undergrowth was very sparse. These features created a cool and shaded effect.

When I first observed these snakes in the hollow, they were about a foot apart with their heads raised from the ground and facing each other. This position seemed to be indicative of some sort of courtship. After striking once, they were easily caught. When I put them in the vasculum I was carrying, they immediately began to make a buzzing sound by vibrating the ends of their tails in the leaves. Both of these specimens were approximately 4 feet in length, the female being the larger of the two.

That evening, while I was holding the pair (one in each hand), the male, with a sudden movement, grasped the female by the back of her head with his jaws and began to coil himself about her until their anal regions were together. The hemipenis was erected by folding out from within itself and was inserted into the vagina of the female. This copulatory position was held for about ten minutes during which time the male continued to hold on to the head of the female, the female putting up some struggle.

Again on June 14, 1940, at 7:15 P.M., as I was observing the snakes in their cage, the male became rather excited and grasped the female at the back of the head. His tail then began swishing until it came in contact with the female and the two anal regions were brought together. During the copulation the male continuously held fast to the posterior head region of the female. For the first ten minutes the female struggled, and then became quiet. During the twenty-five minutes of copulation, the male went through many muscular contractions and lashed frequently with his tail.

The erected hemipenis appeared to be approximately one inch long and when withdrawn from the female it was bloody in appearance. After copulation, both the specimens were very excitable, the female most so.

On July 7, a very similar copulation between this pair was observed.—CHARLES C. CARPENTER, *Department of Zoology, University of Michigan, Ann Arbor, Michigan.*

Ichthyological Notes

NOTES ON THE DEVILFISH, *MOBULA LUCASANA*, AND ITS PARASITES.—On October 3, 1946, the swordfishing boat *Bette Ann*, Captain, Laurence Grohs, left at the pier of the Kerckoff Marine Laboratory a ray that was later identified as *Mobula lucasana*. The ray had been speared between 2 and 3 miles off Laguna Beach, California.

This ray checked with the description of *Mobula lucasana* given by Beebe and TeeVan (1938, Zoologica, 23: 299–312) for the type specimen, which was taken in San Lucas Bay, Lower California, Mexico, on March 30, 1936. The type specimen, the only one heretofore described, measured 40.75 inches in width across the disk.

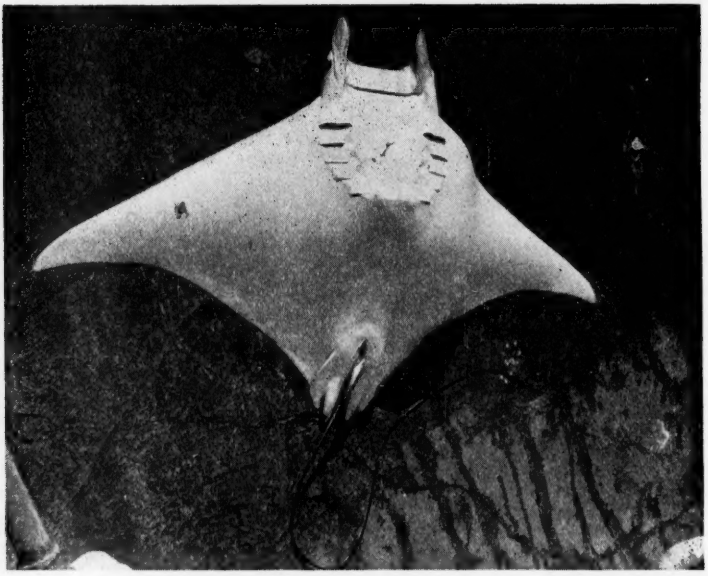

Fig. 1. Ventral view of male *Mobula lucasana*. The long whip-like tail does not bear a stinger.

The following measurements of the specimen we examined agree in proportion with those given for the type specimen:

Extreme width, from tip to tip of wings, 7 ft., 3¼ in.
Length of tail, 6 ft., 5 in.
Length of body from tip of cephalic fin to tip of clasper, 4 ft., 7 in.
Length from tip of clasper to base of cephalic fin, 3 ft., 7½ in.
Width of mouth, 10 in.
Width between tips of cephalic fins, 11½ in.
Overall width of eye, 5½ in.
Width of pupil, ⅜ in.
Length of gill slits, in order from anterior to posterior: 4½ in., 5 in., 5⅛ in., 4⅞ in., 3⅜ in.

In describing the skin, Beebe and TeeVan made no mention of the fact that the upper surface is covered with rows of small pores. One small discrepancy existed between our specimen and the description of the type: the bands of teeth extended at least 76 per cent of the mouth opening instead of 70 per cent as in the type.

In describing the color of the type the authors state: "The preserved type has the underside of the body, anterior to the mouth, and a narrow band along the lower jaw as well as the entire inner surface of the cephalic fin, brownish-black." In our specimen, which had been dead only a short time, the corresponding surface was a beautiful bright blue, and only the tips of the cephalic fins were black.

The gill slits were equipped with what appeared to be very efficient gill rakers. These rakers, which occur on both the anterior and posterior surfaces of the free gill bars, are feathered with pinnately arranged leaflets, averaging 24 pairs to the rachis. Each rachis ends in a spatulate lobe with a central ridge on its outer surface. Each raker is supported by a wedge-shaped cartilaginous fin on its inner surface. This supporting cartilage is about 15 mm. wide at the base and gradually narrows, ending beneath the terminal lobe mentioned above. Looked at from the outer surface, that is, the surface bordering the opening, these rakers are a trifle more than 5 mm. wide. The

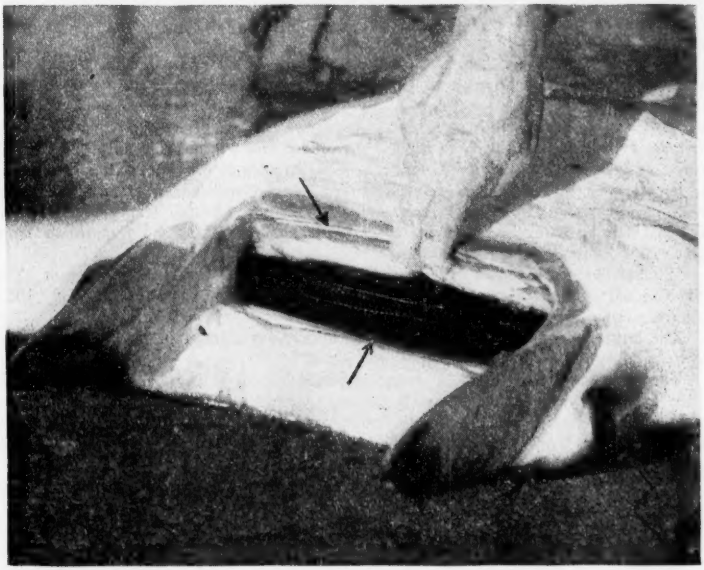

Fig. 2. Mouth of *Mobula lucasana*. A narrow band of fine teeth, indicated by the arrows, occurs on both the upper and lower jaw.

rakers on the anterior side of the gill bar are 44 mm. long near the center and those on the posterior side are 60 mm. long in the central region.

The stomach of this fish was completely filled with euphausiids. Some of the euphausiids and some ectoparasitic copepods from the ray were sent to Dr. Fenner A. Chace, Jr., Curator, Division of Marine Invertebrates, of the United States National Museum, who kindly gave them to the proper persons for identification. The euphausiids were identified by Mr. Paul Illg, Associate Curator of the U.S.N.M., as *Euphausia pacifica* Hansen.

The euphausiids contained in the stomach of this *Mobula* weighed 2597 grams, which, by counting and weighing, were estimated to represent 273,983 individuals. With the exception of a tip from a small colony of the pelagic tunicate *Pyrosoma*, no other planktonic material was found in the mass of euphausiids. The gut, too, was filled with euphausiids, in all stages of digestion.

In view of the above, the fact that the type specimen was caught with a baited hook is surprising, for certainly the mouth and pharynx with its gill rakers are not equipped for capturing prey larger than small shrimps.

When the ray was hauled on deck, a shark-sucker, *Remora remora* (Linnaeus) dropped from its body. This shark sucker, which was 146 mm. long, was still alive when the *Bette Ann* reached our dock. It was exceedingly viable. At first when it was placed in a large tank it swam frantically back and forth, searching for a place to which to adhere. Occasionally it would attach, upside down, to the bottom of the tank, remaining thus for only short periods of time before resuming its restless swimming. Twice it jumped out of the tank onto the cement floor of the laboratory, the last time remaining there from two to three hours. I later moved it to an aquarium in my laboratory, where it lived for several months and became quite tame. It remained attached to the glass sides of the aquarium, sometimes moving very little for several hours at a time. It would come part way out of the water to take food from my fingers. It had a keen sense of smell, for it became alert almost the moment a piece of fish flesh was dipped in the water. It apparently died from some infection which spread within the cavity of the sucker pad on the back of its head.

In comparison with other fishes we have examined, this specimen of *Mobula* was comparatively free from parasites. No parasites at all were found in the alimentary tract.

Two species of copepods were taken from the surface of the body, chiefly from the anterior end and mainly from around the mouth and within the mouth. Mrs. C. B. Wilson reports that both are undescribed species of *Pupulina*. She further states that the only known species of this genus, *Pupulina flores* van Beneden (1892, Bull. Acad. Roy. Sci., Belgique, 24: 241–262), was found on *Manta birostris* from the Galapagos Islands (Wilson, 1935, Parasitology, 27: 593–597) and on *Mobula hypostoma* from Lemon Bay, Florida (Bere, 1936, American Midl. Nat., 17: 577–625).

The smaller of the two new species of copepods had a wine-colored eyespot. The body and tail were transparent, with wine and blue lines and patches over the body. The eggs were salmon-colored.

The larger, and more numerous, copepod also had a transparent body, but without any colored markings, and the eyespot was black.

The larger species of *Pupulina* was itself parasitized by a tiny trematode. Egg cases of the trematode were attached mainly to the tails and appendages of the genital segments of the females. The young trematodes were mainly on the carapaces. Each egg case contained one larval trematode in a late stage of development. Some of the young worms escaped from the cases within the subsequent 24 hours.

Mrs. C. B. Wilson will later publish descriptions and names of these two new *Pupulina*.

I wish to express my thanks to Dr. Carl Hubbs, of the Scripps Institution of Oceanography, for calling my attention to the need for further information regarding this species of ray, and for helping with reference material. The photographs were taken by Mr. John Spikes, a graduate student at the Kerckhoff Laboratories.—G. E. MacGinitie, *Kerckhoff Marine Laboratory, California Institute of Technology, Corona Del Mar, California.*

NOTES ON THE INFLATING POWER OF THE SWELL SHARK, *CEPHALOSCYLLIUM UTER.*—*Cephaloscyllium uter* belongs to the unique genus of sharks capable of considerable inflation of the abdominal region. This ability is not found in any of the other chondrichthians, although in the bony fishes of the families Tetraodontidae and Diodontidae, commonly called the puffers, it is developed to an even greater degree (Breder and Clark, Bull. Amer. Mus. Nat. Hist., 88(5), 1947: 291–319). Since little has been published on the inflating power of the swell shark and nothing on the descriptive anatomy of the expansible stomach, the following notes may be of some interest. The specimens of *C. uter* used in this study were examined from the fish collection of the Scripps Institution of Oceanography through the courtesy of Dr. Carl L. Hubbs.

The stomach of sharks is divided into two parts— the cardiac stomach, which follows the oesophagus, and the pyloric stomach, which follows the cardiac stomach and leads

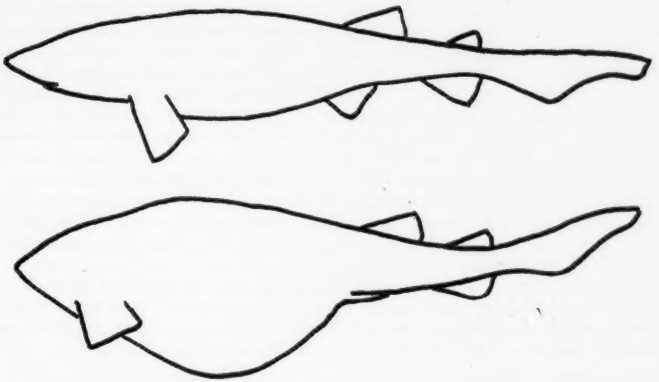

Fig. 1. Outline sketches of *C. uter* in the deflated and inflated states. Based on Walford (1935, Contr. Calif. St. Fish. Lab., No. 117).

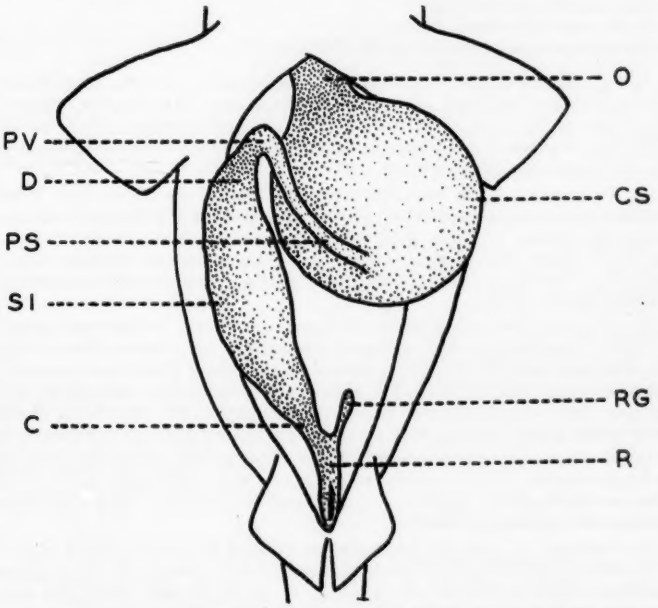

Fig. 2. Diagrammatic sketch of the alimentary canal of *C. uter* showing the cardiac stomach in a semi-inflated state.

C = colon, CS = semi-inflated cardiac stomach, D = duodenum, O = oesophagus, PS = pyloric stomach, PV = pyloric valve, R= rectum, RG = rectal gland, SI = spiral intestine.

into the duodenum. In *C. uter* the cardiac stomach is the organ that inflates. As in the puffer fishes, air or water is gulped into the stomach, inflating the belly region of the fish. The fluid is held in the cardiac stomach of the swell shark by a strong oesophageal sphincter anteriorly and sphincter between the cardiac and pyloric stomachs posterioventrally. The pyloric stomach is flattened out during inflation. It lies, together with the spleen, between the cardiac stomach and the ventral body wall on the right side of the shark. The cardiac stomach swells out in all directions, unlike the condition in the puffer fishes, where the expansible part of the stomach is confined to the ventral region which is pressed against the ventral body wall and does not wedge in any other part of the viscera. The cardiac stomach of the swell shark is completely free from the ventral body wall having no attachments to it such as are present in the diodontids (Rosen, Arkiv. Zool. Upsala, 7(30), 1912: 1–23). In this respect it resembles the condition in the tetraodontids.

When contracted the cardiac stomach lining has many large, deep folds similar in appearance to the cephalic folds of the brain. When expanded the lining becomes comparatively smooth except around the openings to the oesophagus and pyloric stomach.—EUGENIE CLARK, *New York Zoological Society, New York 6, N. Y.*

FISHES NOT PREVIOUSLY REPORTED FROM TEXAS, WITH MISCELLANEOUS NOTES ON OTHER SPECIES.—During a recent trip to Fort Isabel, I observed a number of mounted specimens in a local tackle shop. All of them had been caught in that area. Among them were the following species which have not previously been recorded from Texas:—

Malacanthus plumieri Bloch
Holocentrus adscensionis Osbeck
Epinephelus drummond-hayi Goode and Bean

In the collection of the Texas Game, Fish and Oyster Commission at Rockport, was a small *Chaetodon ocellatus*, without accompanying data. However, according to Mr. A. C. Collier and Dr. Gordon Gunter (both former marine biologists of the Game, Fish and Oyster Commission) there were no foreign or out-of-state specimens in the collection. Dr. Gunter has reported similar fish from Port Isabel.

At Port Isabel I also saw specimens of *Caranx ruber, Sphyraena barracuda, Rhomboplites aurorubens,* and a large saw of *Pristis microdon* which had a tooth count of 18 on the left side, 17 on the right. Moreover, a number of people told me of a very large shark "longer than a snapper boat" which had been seen offshore. After close questioning of several of them, I have concluded that it was probably a whale shark, *Rhineodon typus* (Smith).

On August 8, 1946, collectors for the Marine Laboratory of the Texas Game, Fish and Oyster Commission caught at Port Aransas jetties six species of fishes. Three of them, *Kyphosus sectatrix* (Linnaeus), *Labrisoma nuchipinnis* (Quoy and Gaimard), and *Blennius cristatus* Linnaeus, had not previously been reported from Texas as far as I can determine. Only a single specimen of *Kyphosus* was taken, but some 20 or 30 each of *L. nuchipinnis* and *B. cristatus* were caught, indicating that they are not uncommon.

Of the others, 3 specimens proved to be the somewhat rare *Dules subligarius* (Cope) [*see* Woods, COPEIA, 1942, 3: 191–192]. The others were identified by Dr. S. F. Hildebrand as *Bathygobius soporator* (Cuvier and Valenciennes) and (provisionally) *Hypleurochilus geminatus* (Wood).

On September 13, 1946, the same collectors obtained in a small minnow seine in the surf of Mustang Island 10 small Spanish mackerel, *Scomberomorus maculatus* (Mitchill). Their total lengths were 32, 32, 36, 36, 37, 37, 39, 41, 42, 42 mm. This is the first evidence that we have of this species breeding off the Texas coast.

Two small specimens of the rather rare carangid *Hemicaranx amblyrhynchus* have also been taken near Mud Island in Aransas Bay, on August 20, 1946.—J. L. BAUGHMAN, *Marine Biologist, Texas Game, Fish and Oyster Commission, Rockport, Texas.*

NOTES ON THE MIDSUMMER ICHTHYOFAUNA OF A CONNECTICUT BEACH AT DIFFERENT TIDE LEVELS.—During the latter part of July and early August, 1943 and 1944, 12 collections of fish were made with a 4- x 30-foot minnow seine at Bushnell Beach, Pine Orchard, Connecticut, under comparable circumstances but at different tide levels. This beach, although quite constantly changing its character and slope within certain limits, is composed in the main of coarse sand and gravel with areas of larger stones and occasional rocks. Beyond the low-tide level the bottom is softer in spots, with several patches of mud. The whole area is such that, with a reasonable degree of familiarity and proper weather conditions, collections of fish by small seine can be made efficiently and in almost identical manner. Each collection consisted of two 100-foot hauls—one on each side of a pier—parellel to the shoreline at depths of 2–4 feet. Pairs of hauls at similar tides thus covered essentially the same areas. The high-tide hauls seined a part of the beach that was completely exposed when the tide was out; the hauls made at mid-tide worked the low-water level; and the low-tide hauls covered ground that is never exposed. The entire contents of all hauls were preserved at the time of collection. After identification and sorting by species, median length measurements were made to the nearest millimeter.

Table 1 shows the size distribution by species in eight typical collections on three separate dates; 13 species and over 500 individuals are involved. The numbers of individuals of each sort at each length interval are given for high, middle and low tides on July 25, 1943, and August 6, 1944; no mid-tide haul was made on July 30, 1944.

The movements of each species of fish in relation to the stage of the tide are in part dependent on their feeding habits. The intertidal zone is a relatively impoverished area; only eurythermal and euryhaline invertebrates, usually with special adaptations which render them stenobathic, can withstand its unfavorable conditions. For this reason there is probably no great inducement for demersal, bottom-feeding fish—especially the larger sizes—to come in with the tide to any great extent. However, pelagic and semidemersal fish of small size might logically be expected to occur in this zone, since they feed on plankton and other small organisms, some of which are carried in by the current and some of which are dislodged from the surface layers of the beach by wave action; the shallow water also probably offers these fish some refuge from larger predators. There is the further possibility that the warmer water over the recently exposed beach attracts some of these forms, although it may equally well act as a barrier to others; there is no opportunity for judgment of this factor from these data since all hauls were made on clear, warm days.

Brief notes on the habits of each species with respect to the tide follow:

Anguilla bostoniensis.—Eels tend to be more abundant below the low-tide level, but single individuals of considerable size commonly explore the recently exposed bottom and may be taken close to shore at high tide. This is probably in keeping with the completely omnivorous diet of these demersal scavengers, who, while preying on small fish and crustacea, also apparently search this bottom for the dead organisms that are brought in with the tide or are killed on the exposed beach and made available as the water advances.

Brevoortia tyrannus.—Menhaden were taken on only one date, and then only at middle and high tide. The size range (2–3 cm.) is typical of O-group pogies in these waters in midsummer. This pelagic species schools heavily so that it is usually present in good numbers or not at all. Both at this size and later in the fall when it is larger it is common along the shoreline and comes in over new ground with the tide.

Anchoa mitchilli.—A few isolated anchovies of small size were taken in mid- and low-tide hauls. Their absence from high-tide hauls is probably not significant in view of the small numbers of individuals collected.

Fundulus majalis.—The semidemersal striped mummichog is not abundant in this environment, but it moves in with the tide over recently exposed bottom as might be expected of such an omnivorous, scavenging species.

Syngnathus peckianus.—The demersal adult pipefish (over 15 cm.) do not tend to follow the tide in to any great extent, but the semipelagic young 3-7 cm. long (probably 0- and 1-groups) come in with advancing water, and scattered individuals are not uncommon in high-tide hauls.

TABLE I

SIZE DISTRIBUTION OF FISH IN COLLECTIONS FROM DIFFERENT TIDAL ZONES OF THE CONNECTICUT BEACH

Date and Species	Tide	Length in mm.																								Totals		
		0–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	91–100	101–110	111–120	121–130	131–140	141–150	151–160	161–170	171–180	181–190	191–200	201–300	301–400	401–500	501–600	H	M	L
VII–25–1943																												
Anguilla bostoniensis	H	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	1	1	..
	M	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..			
	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
Brevoortia tyrannus	H	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	46	..
	M	..	..	46	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
Anchoa mitchilli	H	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	8	1
	M	..	2	6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
	L	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
Syngnathus peckianus	H	..	..	..	3	7	2	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	14	3	3
	M	..	..	..	1	1	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..			
	L	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	1	1	..	..	..	..	..	..	..			
Menidia menidia	H	..	4	7	..	..	..	..	..	..	3	1	2	..	..	..	..	..	..	..	..	..	..	..	..	17	6	92
	M	..	..	5	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
	L	..	1	62	27	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
Menticirrhus saxatilis	H	..	..	..	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	1
	M	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
	L	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			

TABLE I (*Continued*)

Date and Species	Tide	Length in mm. 0–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	91–100	101–110	111–120	121–130	131–140	141–150	151–160	161–170	171–180	181–190	191–200	201–300	301–400	401–500	501–600	Totals H	M	L
Tautoga onitis	H	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..
	M	..	..	..	..	..	..	..	..	..	1	..	..	..	..	1	..	..	..	..	..	..	..	..	..			
	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
Spheroides maculatus	H	5	31	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	37	13	36
	M	..	12	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
	L	11	24	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
Microgadus tomcod	H	..	..	..	..	..	..	..	..	2	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	4	1
	M	..	..	..	..	..	..	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
Pseudopleuronectes americanus	H	..	..	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	3	16
	M	..	..	..	..	1	..	1	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..			
	L	..	1	4	2	3	1	3	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..			
																										74	86	150
VII–30–1944																												
Anguilla bostoniensis	H	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	1		5
	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	2	..	..			
Syngnathus peckianus	H	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		5
	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	2	1	..	..	..	..			
Menidia menidia	H	..	..	6	3	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10		..
	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
Menticirrhus saxatilis	H	..	..	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2		5
	L	..	..	1	..	1	2	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			

TABLE I (*Continued*)

SIZE DISTRIBUTION OF FISH IN COLLECTIONS FROM DIFFERENT TIDAL ZONES OF THE CONNECTICUT BEACH

Date and Species	Tide	Length in mm.																								Totals		
		0–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	91–100	101–110	111–120	121–130	131–140	141–150	151–160	161–170	171–180	181–190	191–200	201–300	301–400	401–500	501–600	H	M	L
Tautogolabrus adspersus	H	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		
	L	..	..	..	1	..	..	..	2	..	..	1	3	..	..	..	..	1	..	..	1	..	..	..	..	..		9
Tautoga onitis	H	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		
	L	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..		1
Spheroides maculatus	H	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		
	L	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		1
Microgadus tomcod	H	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		
	L	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		1
Pseudopleuronectes americanus	H	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		
	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..		1
																										13		28
VIII–6–1944																												
Anguilla bostoniensis	H	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		
	M	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	1	
	L	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	3	..	..	1	..		4
Anchoa mitchilli	H	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		
	M	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	
	L	..	1	6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	7
Fundulus majalis	H	..	..	4	9	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		
	M	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	13	..
	L	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..		1

TABLE I (*Continued*)

TABLE I (*Continued*)

Date and Species	Tide	Length in mm.																								Totals		
		0–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	91–100	101–110	111–120	121–130	131–140	141–150	151–160	161–170	171–180	181–190	191–200	201–300	301–400	401–500	501–600	H	M	L
Syngnathus peckianus	H	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	1	..	1
	M	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
	L	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
Menidia menidia	H	..	3	11	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	15	46	33
	M	..	2	24	12	5	2	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
	L	..	..	27	6	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
Bairdiella chrysura	H	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	8
	M	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
	L	..	8	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
Menticirrhus saxatilis	H	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	1	3
	M	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
	L	..	..	1	1	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
Tautogolabrus adspersus	H	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5
	M	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
	L	..	..	3	..	..	..	..	..	..	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
Tautoga onitis	H	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1
	M	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
	L	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..	..	..	..	..	..			
Spheroides maculatus	H	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	3	1
	M	..	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
	L	..	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
Pseudopleuronectes americanus	H	..	..	..	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	2	12
	M	..	..	..	..	1	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..			
	L	..	..	..	..	2	4	3	1	1	..	..	1	..	..	..	..	..	..	..	..	..	..	..	..			
																										33	53	76

Menidia menidia.—The silverside is abundant at all sizes and generally occurs in schools, particularly the smaller fish. It is usually taken in greatest numbers in low-tide hauls, but the young (0-group) pelagic fish and some adults regularly come in with the tide. It is uncommon not to find representatives of this species at any stage of the tide in this locality in midsummer.

Bairdiella chrysura.—Silver perch were taken in only one haul at low tide. It seems probable that these 0-group fish, which are not abundant so far north, were the product of local or at least nearby spawning.

Menticirrhus saxatilis.—Isolated 2–10 cm. kingfish, probably of the 0- and 1-groups, are not uncommon along the shore in this environment in the summer. Although they tend to be more abundant below the low-tide level, they come in over recently exposed bottom with considerable regularity.

Tautogolabrus adsperus.—Cunners were caught in only two sets of low-tide hauls. Even the smaller representatives of this species tend to remain below the low-water level in this environment, where food suited to their browsing habit is unquestionably more abundant.

Tautoga onitis.—Isolated tautog occur quite regularly, but, like the cunner, even the small fish do not follow the tide in to any great extent in this area.

Spheroides maculatus.—The young (0-group), semidemersal puffers follow the tide movement over the smooth bottom and tend to be equally abundant in hauls at all stages of the tide.

Microgadus tomcod.—Young tomcod from the previous winter's spawning occur in limited numbers. In general they tend not to advance beyond the low-tide level, as might be expected of such a notably cold-water fish.

Pseudopleuronectes americanus.—Taken with great regularity, though not in great numbers, the winter flounder tends to be more abundant below the low-tide level; but small individuals advance over smooth bottom with the tide and isolated juveniles are likely to be caught in hauls at any stage. The larger fish remain below the low-tide level.

As the totals in the table show, collections made on the same days have a definite tendency to contain greater numbers of individuals and more species at low tide. Obviously, however, the number of individuals in any haul at any stage of the tide depends in large measure on whether or not the seine happens to pass through a school of small menhaden or silversides. The only other form with pelagic tendencies that comes in with the tide quite regularly at this season, although in limited numbers, is the young pipefish. Demersal species that follow the tide are, in the main, either scavengers such as eels and mummichogs, or the young of such forms as kingfish, puffers and winter flounder, which probably feed on small organisms which are swept in with the tide or dislodged by wave action. All sizes of the two labrids, with their specialized dentition, tend to remain below the low-tide level. The only fishes above 10 cm. that normally come above the low-tide level under the conditions of these collections are occasional eels, pipefish and silversides. That the gear used would take the larger individuals if they were present is evident from hauls made at middle and low tides and from experience. The paucity of adequate food in the intertidal zone for the larger fish of this locality probably makes it unprofitable for them to explore this area, where small size or some other adaptation (heavy shell, capacity to burrow, etc.) is essential for the aqueous requirements and hence for survival of the invertebrates that are exposed as the tide recedes. Finally, it is clear that those eurythermal and euryhaline fish which enter the intertidal zone do so as soon as the water advances; in the accompanying table the mid-tide hauls on July 25, 1943, were made on an incoming tide, while the mid-water collection on August 6, 1944, was taken as the tide was going out. The tabular data here presented are substantiated by corroborative hauls and observation.

It is a pleasure to acknowledge the assistance of George A. Kubler in making the collections and George Townsend in measuring the specimens.—DANIEL MERRIMAN, *Bingham Oceanographic Laboratory, Yale University, New Haven, Connecticut.*

Reviews and Comments

RAW MATERIAL FROM THE SEA. By E. Frankland Armstrong and L. Mackenzie Miall: 177 pages, 21 plates. $3.75.—In recent years, widespread interest has been aroused by the extraction in large quantities on an economic basis, first of bromine and then of magnesium, as hydroxide from the sea. Thus any scarcity or monopoly of bromine has been ended. It is to be expected that other elements will be won directly from the sea in the future, as today several are obtained on the land from deposits representing dried up ancient seas or from those, like the Dead Sea, which are only partially evaporated. This book describes the production of salt, bromine, magnesium, iodine, and potassium salts. It describes processes for obtaining potable water from sea water, and includes three excellent chapters on the oceans, chemicals in the sea, and the bio-chemistry of the oceans.

STATISTICAL ANALYSIS IN BIOLOGY. By K. Mather. Interscience Publishers, New York, 1947 (Offset lithoprint reproduction of the second edition, 1946): 263 pages. —This is the second edition of Dr. Mather's book, which was published originally in 1943, and reviewed in this journal. Misprints, ambiguities and inaccuracies that appeared in the first edition have been corrected; and a new chapter on angular and probit transformations has been added. It is a superb book. It gives the non-mathematical student (Mather describes himself as a non-mathematician) a deeper insight into the principles of statistics than most other statistics books afford. The latter seem either to assume perfect mathematical sophistication and are incomprehensible to all but the lucky few; or else they assume complete naiveté and tend to be mere recipe books. The present work falls into neither of those errors.

CE QU'IL FAUT SAVOIR DES POISSONS DES EAUX DOUCES DE FRANCE. By Pierre Gossot. Paul Lechevalier, Paris, 1946: 201 pp., 20 colored plates. 200 francs.—This little book is an excellent popular general work about the fresh water fishes of France. It deals briefly with their anatomy, physiology, distribution, habits, and relationships; and with their commercial, recreational and culinary values. There are keys, colored illustrations, and descriptions of the principal species. A few marine fishes, like plaice, that occur in estuaries, are also included.

THIS GREAT AND WIDE SEA. By R. E. Coker. University of North Carolina Press, Chapel Hill, 1947: 300 pages, 91 plates, 23 figs. $5.00.—This is a concise, comprehensive account, written in non-technical language, of the oceans, their contents, and the means by which we study them. It treats briefly with history and geography, with chemistry and physics, and with life in the sea. The illustrations are unusually well selected and reproduced.

THE WORLD EXPANDS—RECOLLECTIONS OF A ZOOLOGIST. By George Howard Parker. Harvard University Press, 1946: 246 pp.—One of the pleasantest Harvard memories is of late afternoons in the Biological Laboratory, the graduate students gathered in the seminar room to drink tea and munch crackers, but most especially, on rather frequent lucky days, to listen to Dr. Parker talk. Stories he told at those gatherings are recorded in this book, together with a lot more, woven into an informal biography, delightfully written.

A TREASURY OF FISHING STORIES. Selected by Charles E. Goodspeed. A. S. Barnes and Co., New York: 600 pages. $5.00.—Charles Goodspeed has culled from the world's vast literature about angling, the best of stories and poems. Much of the material was gathered from the Fearing Collection in Harvard College Library. There are 107 selections, by Walton, Thoreau, Audubon, Irving, Masefield, W. H. Hudson, and others equally famous, as well as many less well known writers of fine literature.

UNDERSEAS LOG. From the records of Eddie Bushnell, deep sea diver. As told to M. O'Moran. Caxton Printers, Caldwell, Idaho, 1947: 266 pages, several plates. $4.00—A commercial deep-sea diver describes his experiences in a casual, conversational, and thoroughly interesting way. He makes some fascinating biological references—to a small white eel, for example, which "possesses a radula that will bore into anything . . ." It will bore through the diver's helment from behind, and coming in with the incoming water it will force itself down the diver's throat and choke him.

MANUAL OF LABORATORY GLASS BLOWING. By R. H. Wright. Chemical Publishing Co., Brooklyn, New York, 1943: 11 plates. $2.50.—The materials, tools and processes of laboratory glass blowing are described clearly and simply, with the aim of helping the beginner start from scratch. The author is less concerned with making those things that can now be readily bought, than he is with the production of special apparatus for special purposes.

CONCISE CHEMICAL AND TECHNICAL DICTIONARY. Edited by H. Bennett, Chemical Publishing Co. 1947: 1055 pages. $10.00.—This volume contains about 50,000 definitions of chemical, physical, metallurgical, mineralogical, medical, pharmaceutical, mathematical and botanical terms. It purports to describe "the most important manufacturing processes and machinery, raw materials and finished products, terms used in mechanical, electrical, radio and television engineering, welding and other shop practices, descriptions of every common or rare chemical," etc., etc. Many trade names are included in the dictionary. This is a handy volume to have in the laboratory library.

PRINCIPLES OF MICROBIOLOGY. By Frances E. Colien. C. V. Mosby Co. 1946: 512 pp., 149 figs., 25 plates.—This book deals with those micro-organisms that are pathogenic to man.—LIONEL A. WALFORD, *U.S. Fish and Wildlife Service, Washington, D.C.*

FISHERY RESOURCES OF THE UNITED STATES. A report prepared by staff members of the U.S. Fish and Wildlife Service, and edited by Dr. Lionel A. Walford of that agency. Senate Document No. 51 of 79th Congress, 1945: 135 pp., profusely illustrated. Superintendent of Documents, large stock on hand. $0.50.—The report deals primarily with commercial fisheries, to a minor extent with sport fisheries. Fishery resources are grouped by major geographical divisions of the United States and its outlying possessions; the larger, pelagic species are considered on a world basis. For each species or closely related group there is information on most of the following: facts of life history and ecology which are pertinent to conservation of the stock, a summary of present catch statistics and a review of the history of the fishery, the present status of the resource, the degree of development of fishing operations, and what if anything is being done or might be done in the future in the way of management of the fishery. For most species very little or nothing is said about management. Significantly, it is stated that "there is only one example of a fishery resource that has been successfully studied and conserved over most of its range." The many charts, graphs, photographs and figures, including satisfactory drawings of most fish species, should be well received by both layman and student of fishes.

The report has been republished, copyright by Public Affairs Press, Washington 8, D.C., 1947, 134 pp., edited by Dr. Walford; cloth, $5.00. All text and illustrations of the original are duplicated almost exactly, with a substitution of green color for black in the illustrations; but most obvious is the almost complete omission of reference to the official nature of the report or to the fact that the report was prepared by the Fish and Wildlife Service. Also omitted is the two-page section on "Conclusions and Recommendations." Certainly these omissions will make the Public Affairs Press edition of the report less meaningful to the reader, if not less useful.—GERALD P. COOPER, *University Museums Annex, Ann Arbor, Michigan.*

CLASSIFICATION OF FISHES, BOTH RECENT AND FOSSIL. By Leo S. Berg. Photolithographic reprint of the entire work, including Russian section and complete English translation, Edwards Brothers, Inc., Ann Arbor, Michigan, 1947: 87–517, 190 figs. $7.00, cloth.—For a review of the original edition, see COPEIA, 1941: 274.

EDITORIAL NOTES AND NEWS

Summary of the 1947 Meeting

THE twenty-seventh annual meeting of the AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS was held at Higgins Lake, Michigan, August 27 to 30, 1947. The meeting opened Wednesday afternoon with registration and an informal get-together in the Administration Building of the Higgins Lake Training School of the Michigan Department of Conservation.

Governors' Meeting

THE Board of Governors' meeting was called to order at 8 P.M. by PRESIDENT HUBBS, with 24 Governors and 8 invited guests in attendance. Since the 1946 minutes had been published in COPEIA their reading was dispensed with. The 193 persons added to the rolls between April 1, 1946, and Aug. 15, 1947 were formally elected to membership. Four Governors, JOHN R. DYMOND, W. J. K. HARKNESS, KARL F. LAGLER, and TRACY I. STORER, whose terms expired at this meeting, were re-elected to serve until 1952, and five additional members, W. I. FOLLETT, COLEMAN J. GOIN, ARNOLD B. GROBMAN, GEORGE P. MEADE, and A. M. WOODBURY, were elected for a five-year term. The SECRETARY reported that the Society had 23 fully paid Life Members, 8 partially paid Life Members, and $2954.84 in the Endowment Fund. He reported, also, that the Special Gift Fund totalled $2,575.00. MR. STOYE reported that the Revolving Research Fund, established at the 1946 meeting, had received $1478.25 in contributions from 100 members of the Society, and $165.00 from other sources, making a total of $1643.25. The question of continued support for the *Zoological Record* was discussed and the TREASURER was empowered to increase the Society's gift for the 1946 *Record* to 25 pounds.

The SECRETARY offered the following amendment to the By-Laws: *Resolved*, that Article III, Section I, shall be further amended to increase the number of Honorary Foreign Members to twenty, evenly divided between herpetologists and ichthyologists. This amendment was passed without dissenting vote, the list of present Honorary Foreign Members was read, and three ichthyologists and three herpetologists were nominated from the floor. Four of these, the ichthyologists, A. V. TANING and J. L. B. SMITH, and the herpetologists F. ANGEL and C. C. LIU, were elected by ballot, bringing the present total to 19 and leaving one vacancy to be filled next year.

The SECRETARY announced that the TREASURER had requested consideration of an increase in dues and subscription rates, necessitated by increasing publication costs and other Society expenses. After discussion the following amendment to the By-Laws was passed with two negative votes: *Resolved*, that Article III, Section II, as amended May 12, 1931, shall be further amended to read "Membership dues shall be $4.00 per year, and subscriptions to COPEIA shall be $5.00 per year, both effective for the year 1948."

The SECRETARY pointed out that Society correspondence had increased so tremendously since the end of the war that it was impossible for his secretary to handle it in time spared from her regular duties. By unanimous action the SECRETARY was empowered to employ part-time secretarial help, to the extent of $100.00 to $150.00 per year, for the conduct of Society business.

The PRESIDENT recommended that the SECRETARY be reimbursed by the Society for his travel and subsistence expenses in connection with annual meetings. This motion was carried, and it was further moved that the action be made retroactive to include the present meeting.

KARL P. SCHMIDT, who represented the Society at an organization meeting of the American Institute of Biological Sciences in Washington in April, detailed the need for such an Institute, outlined its scope, and made a strong plea that our Society should join the Institute, which would entail an annual payment of $1.00 per paid-up member. After lengthy discussion the Board went on record as strongly recommending that the Society join the Institute. It declined to commit the membership to such momentous action without a voice in the matter, and instructed MR. SCHMIDT and the SECRETARY to canvass the members by mail, the final action of the Society to be determined by a majority vote of those replying within sixty days of the date of mailing of the ballots. The Board further

provided that, in the event of Society affirmation, only paid-up Western Hemisphere members would be counted in computing the payment due the "American" Institute, and that the added $1.00 assessment would not be made until 1949.

DR. LAGLER, our representative at the Chicago meeting of the Natural Resources Council of America, in March, reported upon the aims of this organization and stressed the fact that scientific societies would be called upon to furnish advice upon conservation matters rather than major financial support. The Board voted that the Society should join the Council, and endeavor to forward its work, but did not commit the Society to any financial participation.

The CHAIRMAN appointed the following committees: *Nominating*—EDWARD C. RANEY, JOSEPH R. BAILEY, WILLIAM A. GOSLINE; *Resolutions*—JOHN R. DYMOND, K. P. SCHMIDT; *Prize Award*—CHARLES F. WALKER, ROBERT R. MILLER, E. H. BEHRE, JAMES A. OLIVER; *Auditing*—F. H. STOYE.

DR. WALFORD'S resignation as *Ichthyological Editor* was accepted, and the SECRETARY was asked to express the thanks of the Society for his faithful service in this capacity.

MR. SCHMIDT reported upon plans for the sixth edition of the *Check List of North American Amphibians and Reptiles*. He signified his willingness to proceed with preparation of a check list, to be based upon current literature and to be ready for publication in 1950. Announcement will be made in COPEIA to enable workers to publish nomenclatorial changes. Various Governors expressed their approval of the proposal, and favored Society publication of the check list, but final action was deferred to the annual business meeting. DR. HUBBS reported that there was no possibility of publishing a check list of North American fishes in the near future, but that several regional check lists are in preparation by individual members.

DR. FRANCIS N. CLARK brought the greetings of the Western Division and presented several matters on which the Western Division requested action. In response to her request that the Western Division territory be delimited, a motion was made and carried that it be fixed as that portion of the United States and Canada west of the Rocky Mountains, or more specifically, Montana, Wyoming, Colorado, New Mexico, all states lying west of these, and British Columbia, Alaska and the Hawaiian Islands. The Board approved affiliation of the Western Division with the Pacific Division of the A.A.A.S., and instructed the SECRETARY to communicate with the A.A.A.S. on this matter. The Board also moved that the Western Division be empowered to submit bills for running expenses to the national TREASURER, the annual total not to exceed $.25 per paid-up member in its designated area.

The SECRETARY submitted tentative drafts of three needed amendments to the By-Laws, which after some emendations were passed in the following form:

Resolved, that Article IV shall be amended by the addition of the following Section 4: "The officers of the Society shall be an Honorary President for Ichthyology, an Honorary President for Herpetology, each elected for an indefinite term; a President, elected for a two-year term, eligible for a second term only after a lapse of two or more years; three Vice-Presidents elected for one-year terms but eligible for immediate re-election; a Treasurer, a Secretary, an Assistant Secretary, and a Historian, all of whom must be re-elected annually but who may serve unlimited consecutive terms; an Editor-in-Chief, an Ichthyological Editor, a Herpetological Editor, each of whom shall be elected annually but who may serve unlimited consecutive terms, and an Editorial Board of five members, each of whom shall be elected annually but who may serve unlimited consecutive terms. The Editors, Editorial Board, President, Secretary, and Treasurer shall constitute the Publications Committee of the Society."

Resolved, that Article IV shall be amended by the addition of the following Section 5: "The duties of the officers shall be those commonly assigned to the particular offices, with added responsibilities as follows: The First Vice-President shall have charge of all conservation matters and shall serve as Chairman of the Conservation Committee; the Second Vice-President shall have charge of the Revolving Research Fund and shall serve as Chairman of the Revolving Research Fund Committee; the Third Vice-President shall be expected to devote his attention to the obtaining of new members, in all classifications, and shall be Chairman of the Membership Committee."

Resolved, that Article III, Section 3, shall be further amended by changing "$75.00"

to read "$100.00" and by changing "three annual payments" to read "four annual payments," effective January 1, 1948.

KARL P. SCHMIDT was unanimously recommended for re-appointment to represent the Society at the meetings of the Division of Biology and Agriculture of the National Research Council for a three-year term to begin at the expiration of his present term.

After incidental discussion the meeting adjourned at 11:30 P.M.

Sessions of August 28

PRESIDENT HUBBS called the morning session to order at 8:05 A.M. and introduced RUSS L. MARTIN, genial Director of the Training School, who welcomed the Society and then gave a brief history of the School. VICE-PRESIDENT GROBMAN presided for the reading of the following papers:

1. **Studies on the black swamp snake, *Seminatrix pygaea* (Cope).**—Herndon Dowling, Jr.
2. **Notes on Tennessee *Ambystoma*.**—Glenn Gentry.
3. **Observations on the breeding habits of *Eleutherodactylus bufoniformis*.**—Harry G. M. Jopson.
4. **Food Habits of the green frog, *Rana clamitans*.**—William J. Hamilton, Jr.
5. **An analysis of returns of marked *Pseudacris brachyphona*.**—N. Bayard Green.
6. **A colony of ring-neck snakes in northern Michigan.**—M. Ruth Gilreath and Frieda Cobb Blanchard.
7. **The seasonal incidence of snakes.**—James Oliver.
8. **Preliminary notes on haemoglobin and temperature tolerances with reference to vertical distribution of Guatemalan Bufos.**—L. C. Stuart.
9. **Faunal relations of Oregon amphibians and reptiles.**—Kenneth Gordon.
10. **Ophidian faunas of eastern Brazil.**—Joseph Bailey.

Following luncheon, the afternoon session convened at 1:10 P.M., with PRESIDENT HUBBS presiding, for the reading of the following papers:

11. **Collection of fishes for taxonomic and distributional studies by means of electric shocker.**—R. E. Johnson and L. E. Hiner.
12. **Some possible uses of x-rays in ichthyological work.**—W. A. Gosline.
13. **The 1946 meeting of the International Council for the Exploration of the Sea.**—J. R. Dymond.
14. **The ecology and distribution of reef fishes at Bikini atoll.**—Loren P. Woods and Leonard P. Schultz.
15. **Guatemala—land of eternal spring.**—R. R. Miller.

At the conclusion of the afternoon session the members adjourned to Higgins Lake for a swim and then reassembled on the shore at 6 P.M. for the Annual Banquet, a delicious venison dinner prepared and served by the staff of the Training School in a setting unequalled by any sumptuous banquet hall. At 7:30 the group moved to the Class Room where the door prize, a beautiful hand-colored photographic enlargement by RUSS L. MARTIN, was presented to winner LOREN P. WOODS. Following this, MR. MARTIN gave a very entertaining talk on the scenic beauties of Michigan, illustrated with his magnificent Kodachrome slides. At the conclusion of this talk, which impressed even the California delegates, a bronze head of CARL L. HUBBS, by the famous University of Michigan sculptor CARLETON W. ANGELL, was unveiled by a group of his former students. PRESIDENT HUBBS then delivered his presidential address, a very thought-provoking analysis of the needs of ichthyology in the United States.

Sessions of August 29

THE morning session was called to order by PRESIDENT HUBBS at 8:12 A.M. for the reading of the following papers:

16. **The speciation of the genus *Gibbonsia*.**—Clark Hubbs.
17. **Taxonomic characters and growth of the metamorphosed northern lamprey *(Ichthyomyzon unicuspis)* from Quebec.**—Vadim-D. Vladykov.
18. **Comparison between exterior characters of two species of sturgeon from Quebec.**—Vadim-D. Vladykov.
19. **Factors affecting the occurrence of hybrid fishes in Ohio.**—Milton B. Trautman.
20. **Evidence of a changing fish fauna in Indiana.**—Shelby Gerking.
21. **Evidence of a changing fish fauna in Ohio.**—Milton B. Trautman.
22. **Field observations of the white bass, *Lepibema chrysops*.**—Carl D. Riggs.
23. **The fish populations of Lake Myosotis and Lincoln Pond, New York.**—Hurst H. Shoemaker.

The afternoon session was called to order by VICE-PRESIDENT TRAUTMAN at 1:10 P.M. and the following papers were presented:

24. **Brief notes on the fishes of Grand Isle, Louisiana, with special reference to breeding season.**—E. H. Behre.
25. **Observations of the reproductive behavior of yellow pikeperch, *Stizostedion vitreum vitreum* (Mitchill), in Lake Gogebic, Michigan.**—P. H. Eschmeyer.
26. **A mathematical analysis of certain aspects of the evolution of a race of salamanders.**—Arnold B. Grobman.
27. **Osteology of the worm snake, *Typhlops jamaicensis* (Shaw).**—Howard E. Evans.

Business Meeting

PRESIDENT HUBBS called the annual business meeting to order at 3:05 P.M. The minutes of the 1946 meeting, already published in COPEIA, were not read.

The SECRETARY reported that 193 members were added to the rolls during the seventeen months since the previous meeting; 6 members died, 15 resigned, 39 were dropped, and 4 moved without leaving a forwarding address. These losses totalled 64, making a net gain of 129 members, and increasing the total membership to 824. Thirty-nine new subscribers were obtained and 5 subscriptions were cancelled, resulting in a net gain of 34 and increasing the subscription list to 219. The combined total of 1043 members and subscribers is a new high for the Society. Since the previous meeting so many foreign memberships and subscriptions were renewed that 156 copies of COPEIA now go to 33 countries, Canada leading with 40, followed by U.S.S.R. with 21, and Great Britain with 16. Domestic copies total 887, reaching each of the 48 states. California has moved into first place with 122, New York has dropped into second place with 117, and Michigan with 69 has forged ahead of Pennsylvania. The SECRETARY announced with regret the deaths of the following members: WILLIAM E. BELANSKE, C. S. BRIMLEY, HUBERT LYMAN CLARK, W. P. HAY, ROBERT B. MCLAIN, and RICHARD T. SMITH.

The SECRETARY summarized the TREASURER'S report for the calendar year 1946, as follows: receipts, including $812.32 from sale of back numbers and $422.44 in payment of reprint bills, totalled $3,754.47; expenditures, including $2,329.61 for publication of COPEIA and $428.35 for reprints ordered by authors, totalled $3,358.67. MR. STOYE, Chairman of the *Auditing Committee*, reported that the financial statements placed in his hands were correct and in good order.

The SECRETARY summarized the actions taken at the Board of Governor's meeting. The members present approved the increase in dues and subscriptions, and authorized the SECRETARY to collect $4.00 for 1948 from each annual member, including the balance due from any who have paid $3.00 in advance.

PRESIDENT HUBBS called attention to the fact that the Revolving Research Fund is available for use and asked teachers to encourage their students to make application for grants-in-aid.

KARL P. SCHMIDT explained the American Institute of Biological Sciences and emphasized that the Board of Governors had unanimously approved the Society joining, subject to confirmation by a mail ballot of the membership. No objections to this course of action were forthcoming.

MR. SCHMIDT also reported plans for the next edition of the check list. He indicated that the treatment of each species would probably include scientific name, common name, original citation and type locality, synonyms and type localities, citation to best description, range, and possibly other items. It was moved that he be authorized to proceed with the check list, along the lines outlined, that he present a progress report next year, and that the check list be published under the imprint of the Society. This motion was carried.

The *Nominating Committee* presented its report. No nominations from the floor were offered. The report was accepted and the SECRETARY was asked to cast a ballot for the following officers: JOHN TREADWELL NICHOLS and HELEN T. GAIGE, *Honorary Presidents;* CARL L. HUBBS, *President;* CHARLES F. WALKER, F. H. STOYE, JAMES A. OLIVER, *Vice-Presidents;* M. GRAHAM NETTING, *Secretary;* LOREN P. WOODS, *Asst. Secretary;* ARTHUR W. HENN, *Treasurer;* HELEN T. GAIGE, *Editor-in-Chief;* GERALD P. COOPER, *Ichthyological Editor:* KARL P. SCHMIDT, *Herpetological Editor;* REEVE M. BAILEY, E. R. DUNN, NORMAN HARTWEG, RAYMOND E. JOHNSON, ROBERT R. MILLER, *Editorial Board;* WALTER L. NECKER, *Historian.*

Future meeting places were discussed. The members then voted to hold the next meeting in Louisiana in the spring of 1948, and empowered the officers to proceed with arrangements with respect to place and dates. Desirable meeting places for future years were discussed. Another joint meeting with the Western Division was favored. DR. ROMER invited the Society to meet at Cambridge whenever convenient, and MR. BURTON issued a similar invitation to Charleston, South Carolina. A motion of preference was passed favoring meetings within the next five years, in the northeast, southwest, west, Quebec, and West Virginia.

The matter of sending further relief parcels to European ichthyologists and herpetologists was considered and the SECRETARY announced that he was turning the responsibility for this matter over to ASSISTANT SECRETARY WOODS so that it might be attended to with greater dispatch.

The SECRETARY outlined the situation with respect to back numbers of COPEIA and promised to list the scarce numbers in COPEIA in the hope of obtaining duplicates or unwanted copies from some of the members.

The desirability of appointing the nominating committee in advance was stressed by several members and it was moved that the PRESIDENT be instructed to appoint this committee not less than two weeks prior to an annual meeting.

MR. SCHMIDT called the attention of the group to the newly formed Society for the Study of Evolution and invited all those interested to join. DR. DYMOND raised the question of the proper pronunciation of COPEIA and the SECRETARY was asked to investigate and report on this at the next meeting. The SECRETARY read several communications from the National Research Council. Those present did not deem it necessary that we give any consideration to the matter of university patent policies, and with respect to the second matter, that of fostering international relations in our science, the members expressed the opinion that such policy should be determined by the PRESIDENT, with the advice of the other officers. The SECRETARY read a letter from DR. KLAUBER asking for a consideration of the desirability of fixing, within certain limits, the prices to be paid for specimens in various categories. Those present declined to favor price standardization. The business meeting adjourned hastily when the dinner gong sounded.

Annual Smoker

FOLLOWING an excellent dinner the members reassembled in the Class Room at 7:30 P.M. for the annual smoker. DR. HARTWEG presented colorful movies of the Mexican volcano, Paricutin, which he accompanied by an extremely witty and informative commentary. The *Prize Award Committee* presented the first prize in ichthyology, a check for $25.00 to P. H. ESCHMEYER for his paper "Observation of the reproductive behavior of yellow pikeperch, *Stizostedion vitreum vitreum* in Lake Gogebic, Michigan," and the first prize in herpetology, of similar amount, to HERNDON DOWLING, JR., for his paper "Studies on the black swamp snake, *Seminatrix pygaea*." No second prizes were awarded. The *Resolutions Committee* presented the following resolutions, which were passed unanimously and enthusiastically:

Whereas, the A.S.I.H. has concluded a highly successful 27th annual meeting at Higgins Lake, Michigan, and *whereas* the success of this meeting was due largely to the excellent facilities provided by the Michigan Department of Conservation at its Conservation Training School.

Therefore, be it resolved, that the members wish to express their deep gratitude for use of the facilities and for the hospitality provided. They wish to commend especially Mr. Russ Martin, Director of the Conservation Training School for his untiring concern on their behalf.

Whereas, the A.S.I.H. has just concluded a highly successful 27th annual meeting at Higgins Lake, Michigan, and *whereas* the success of this meeting was due in large measure to the careful preliminary planning and to the later efficient execution of these plans on the part of the local committee.

Therefore, be it resolved that the members wish to express their sincere appreciation for the work of the local committee; on behalf of the entire membership they want to express appreciation for the preparation and mailing of the abstracts of the papers to be presented.

MR. BEN EAST's Alaskan film, which included many fine natural history shots, was shown, accompanied by dialogue by PRESIDENT HUBBS and the audience. At the conclusion of the entertainment portion of the program the members devoted themselves wholeheartedly to the variety of refreshments provided by the *Smoker Committee.*

The highly successful 27th annual meeting closed on Saturday morning with the register showing a total attendance of 125. The scheduled boat trip down the Au Sable River was cancelled because most of those in attendance were anxious to leave promptly to avoid Labor Day traffic. A few members remained to make local excursions.—M. GRAHAM NETTING, *Secretary.*

News Notes

ASSOCIATES of our distinguished President, CARL L. HUBBS, will be gratified to learn that the University of Michigan is the recent recipient of a bronze head of Dr. Hubbs, the gift of a group of his former students, colleagues, and friends. The original of the head was done by Carleton W. Angell in 1944. It is now rendered in reddish-bronze and mounted on a marble block placed on a custom, octagonal, walnut pedestal. The remembrance was unveiled at the recent annual convention of the A.S.I.H. As a personal token to his years of service at Michigan, Dr. Hubbs was given a framed photographic enlargement of the work.

DR. CLAUDEOUS J. D. BROWN has resigned his position with the Fish and Wildlife Service to join the staff of the department of zoology and entomology at Montana State College, Bozeman, Montana. He is undertaking a fish survey of the state and plans to publish an account of Montana fishes within a few years.

Foreign ichthyologists recently or currently visiting this country include: HERMANN KLEEREKOPER, Limnologist, Division of Game and Fisheries (Gov't. of Brazil), Porto Alegre, Brazil, here on a Department of State one-year fellowship in the U.S. Fish and Wildlife Service, primarily interested in commercial fisheries, visiting the Great Lakes laboratory at Ann Arbor and several marine laboratories. A party from the Swedish Gov't., Department of Agriculture, including DR. JÖRAN HULT, Fishery Inspector, MR. M. V. FURUSKOG, Fishery Engineer, and DR. GUNNAR ALM, Director, all from the Freshwater Fishery Station at Drottningholm, spending six weeks in the Canadian Provinces and the United States, from East Coast to West, interested primarily in salmon and trout. MR. PH. WOLF, Swedish Salmon and Trout Assn., Ystadgatan 22, Malmö, Sweden, spent August and September of 1947 touring the northern states, Canada and Alaska, visiting numerous research stations and fish hatcheries. Mr. Wolf is active in research on the rehabilitation and conservation of salmon runs in rivers of Sweden.

The MARINE LABORATORY of the TEXAS GAME, FISH AND OYSTER COMMISSION, situated at Rockport, Texas, is rapidly approaching completion and should be ready for tenancy by the first of the new year. A two-story brick and concrete structure, it will contain a downstairs laboratory, 15 x 40 feet, and an upstairs laboratory, 40 x 40 feet, in addition to the necessary offices, store rooms and a penthouse for meterological instruments. The laboratory, which is now housed in a temporary building, possesses rather good boat equipment. There is the 52-foot, diesel-powered houseboat "Vivian," to be utilized when the staff is operating on the northern or southern portions of the coast too far from the main laboratory to make it feasible to travel back and forth. The "Vivian" will sleep 10 people, has a mess room, galley and a shower bath. In addition, the 38-foot "K T" is equipped with trawling and net handling gear for use in deeper water or as an oyster dredge. Two 27-foot Richardson cruisers, an 18-foot power skiff for handling nets, one other skiff and three barges for use in oyster work make up the balance of the fleet.

The facilities of the laboratory are open to independent investigators interested in marine problems, particularly those of the Texas coast. At present the staff consists of MR. J. L. BAUGHMAN and MR. BYRON B. BAKER, JR., and the laboratory is engaged in the investigation of the crabs and oysters of the Texas coast.

This is the second marine laboratory to be built in Texas during the past year, the other being the TEXAS INSTITUTE OF MARINE SCIENCE, sponsored by the Texas University, and under the direction of DR. E. J. LUND.—J. L. BAUGHMAN.

Word is received of the death of DR. W. E. ALLEN on September 20, 1947. Dr. Allen was formerly the phytoplankton specialist at Scripps Institution. He worked primarily on the basic food supply of marine fishes and made some observations on the feeding behavior of fishes and other vertebrates.

The WILDLIFE MANAGEMENT INSTITUTE announces plans for the 13th North American Wildlife Conference, to be held in the Jefferson Hotel, St. Louis, Missouri, March 8–10, 1948. A planned series of papers by selected speakers, on the general theme of "Wildlife Wealth, If We Want It," will be summarized at the end by EDWARD H. GRAHAM, noted author and biologist of the Soil Conservation Service.

The SECRETARY wishes to announce that lithoprinted copies of five out-of-print numbers of the Old Series of COPEIA are now available at the following prices: nos. 44, 152, 161 (8 pages each) at $.25 per copy, and nos. 168 and 172 (32 pages each) at $.75 per copy.

Word is received of the recent death of DR. EDWARD PHELPS ALLIS, JR., a leading American student of the comparative anatomy of fishes, long a resident of Palais de Carnoles, Menton, France.

The new SOCIETY FOR THE STUDY OF EVOLUTION has recently published the first issue (Vol. I, Nos. 1–2, March-June, 1947) of *Evolution*, edited by ERNST MAYR. Subscriptions to the journal ($6.00 per volume) may be ordered through K. P. SCHMIDT, Chicago Natural History Museum, Chicago 5, Illinois. Applications for membership in the society ($5.00 annual dues) should be sent to DR. STANLEY S. CAIN, Cranbrook Institute of Science, Bloomfield Hills, Michigan.

DR. SUNDER LAL HORA, an Honorary Member of the Society, has lately become Director of the Zoological Survey of India, in which position, his American colleagues trust, he will again bring to completion a stream of contributions to knowledge of the fish fauna of India. Dr. Hora's address is "Kaiser Castle," Benares Cantonment, U. P. DR. S. JONES announces his change of address to: Inland Fisheries Research Station, 50A, Theatre Road, Calcutta, India.

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COPEIA IS THE JOURNAL OF THE AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS

Back numbers of COPEIA, as available, may be procured through the Secretary. Prices will be furnished on application.

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Manuscripts should be submitted on good paper, as original typewritten copy, double-spaced, carefully corrected. Galley proof will be furnished authors.

Original contributions, not to be published elsewhere, are alone acceptable.

Reprints are furnished at approximate cost.

Figures, author's corrections, expensive tabular matter and unusually long articles may be charged in whole or in part to the author, at the discretion of the Editors.


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